THE GAS JOURNAL

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A Glance at the Contents—

The Index.

Included with this issue of the "JOURNAL" is the index to Vol. 204, covering the October-December quarter of 1933.

Colonial Gas Association.

The Forty-fifth Annual General Meeting of the Colonial Gas Association, Ltd., was held at Melbourne on Oct. 4, 1933, Mr. P. C. Holmes Hunt, M.Inst.C.E., Chairman of Directors, presiding. [p. 86.]

Australian Gas Institute.

The Seventh Convention of the Australian Gas Institute opened at Melbourne on Nov. 14, when Mr. C. F. Broadhead, Engineer of the Metropolitan Gas Company, delivered his Presidential Address. [p. 94.]

Experiments with Service Governors.

In a paper before the Western Junior Gas Association, Mr. N. F. D. Wardle, of Bath, expresses the opinion that it is not only desirable but necessary to have a governor on every service if maximum efficiency is to be obtained from consumers' apparatus. [p. 103.]

Pressure Recorder for Waterless Holders.

A pressure recorder for waterless gasholders, which is fully patented and is sold by Messrs. Walker, Crosweller, & Co., Ltd., is described and illustrated. [p. 87.]

Design of Town Gas-Fired Furnaces.

In a paper before the Midland Junior Gas Association Mr. F. L. Atkin, A.M.I.Mech.E., of the Birmingham Gas Department, dealt with the design of town gas-fired furnaces for temperatures of 600° C. to 1200° C. [p. 104.]

Testing of Bituminous Mixtures.

In a paper read before the Public Works, Roads, and Transport Congress, Mr. W. G. Adam, B.A., and Mr. D. G. Murdoch, B.Sc., discussed some of the factors involved in the mechanical testing of bituminous mixtures. [p. 99.]

Results of Two C.O.L. Plants.

The operating results are published of two C.O.L. intermittent vertical chamber installations—at the Brentford Station of the Gas Light and Coke Company, and the Vancouver plant of the British Columbia Electric Power and Gas Company. [p. 91.]

Forthcoming Engagements

Jan. 13.—SCOTTISH JUNIOR ASSOCIATION.—Joint Meeting in Glasgow.

Jan. 17.—B.C.G.A.—Meetings of Executive Committee, 11.30 a.m.; General Committee, 2.30 p.m., 28, Grosvenor Gardens, S.W. 1.

Jan. 18.—S.B.G.I.—Meeting of Council, 2.30 p.m.

Jan. 18.—SOUTHERN ASSOCIATION (WESTERN DISTRICT).—Commercial Meeting, Rougemont Hotel, Exeter, 2.30 p.m.

Jan. 20.—WESTERN JUNIOR ASSOCIATION. — Meeting at Weston-super-Mare. Papers by Mr. K. G. Bodiley and Mr. K. L. Clark.

Jan. 26.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting. Paper by Mr. W. E. Benton.

Jan. 30.—I.G.E.—Meeting of General Research Committee, 2.30 p.m.

Jan. 31.—INSTITUTION OF CHEMICAL ENGINEERS.—Meeting. Papers by Mr. H. Hollings and Mr. L. Silver on "Washing of Gas."

Feb. 1.—MIDLAND JUNIOR ASSOCIATION.—Meeting. Paper by Mr. E. L. Wallis.

Feb. 5.—INSTITUTION OF CHEMICAL ENGINEERS.—Meeting of Chemical Engineering Group. Paper by Messrs. H. Hollings and S. Hay on "Recovery of Benzole by Activated Carbon."

Feb. 12.—I.G.E.—Meetings of Finance Sub-Committee, 1.45 p.m.; Membership Sub-Committee, 2.30 p.m.; General Purposes Committee, 3.15 p.m.

Feb. 13.—I.G.E.—Meetings of Council, 10 a.m.; Gas Education Executive Committee, 4 p.m.

Feb. 16.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting. Paper by Mr. P. Lloyd.

Feb. 17.—SCOTTISH EASTERN JUNIOR ASSOCIATION.—Visit to Portobello Power Station. Paper by Mr. W. Masterton.

Feb. 22.—JUNIOR ASSOCIATIONS.—Joint Visit to British Industries Fair.

March 8.—MIDLAND JUNIOR ASSOCIATION.—Meeting. Paper by Mr. H. J. Reynolds.

March 10.—WESTERN JUNIOR ASSOCIATION.—Meeting at Plymouth. Paper by Mr. A. R. Langford.

March 16.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting. Paper by Mr. L. T. Minchin.

April 6.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting. Paper by Mr. H. H. Brown.

April 7.—SCOTTISH EASTERN JUNIOR ASSOCIATION.—Visit to Messrs. J. G. Stein & Co., Castle Carey. Paper by Mr. R. Malcolm.

April 12.—MIDLAND JUNIOR ASSOCIATION.—Meeting. Paper by Mr. F. H. Bate.

April 21.—WESTERN JUNIOR ASSOCIATION.—Meeting at Bath Presidential Address and Annual General Meeting.

April 26.—MIDLAND JUNIOR ASSOCIATION.—Annual Meeting. Address by Mr. R. S. Ramsden.

May 4.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Annual Business Meeting.

EDITORIAL NOTES

Testing Road Materials

IMPORTANT work destined to have a most beneficial effect on the popularity of tar for road making is being carried out in the recently equipped laboratory for the mechanical testing of road materials at the Products Works of the Gas Light and Coke Company; and an account in this "JOURNAL" of some of the results of the investigation will prove helpful to all interested in the application of tar to this purpose. As will be gathered from the account, which is by Messrs. W. G. Adam and D. G. Murdoch, the testing of road materials, and correlation of laboratory results to actual usage of these materials, are highly complex. The technique of testing for mechanical properties is in its early stages of development, and it is highly desirable to formulate methods which combine simplicity and speed with the required degree of accuracy. This end the work of the Gas Light and Coke Company—and such research as that undertaken by Dr. Herrmann at the Berlin Municipal Laboratory and by the Road Research Laboratory at Harmondsworth—is seeking. Already substantial progress has been made; and a glimpse of the nature of this progress is given in the paper on later pages.

The aim of the work described is to determine the conditions of testing necessary to obtain consistent results, with a view to their subsequent interpretation from the strictly practical point of view of road service. The preparation of specimens for test has demanded a great deal of consideration, and is dealt with fully; and it is appropriate that the work at Beckton has been carried out with such apparatus and specimens as will allow results to be compared with those obtained at the two well-established laboratories at Harmondsworth and Charlottenburg. As the authors point out, the tensile and compressive strength of solid materials have long been measured, and the testing machines and apparatus have been brought to a high standard of perfection; these properties can be readily measured for a large number of materials used in road construction, and their useful interpretation is a matter which should have careful consideration. It has been claimed that mechanical tests on bituminous road mixtures are not capable of useful interpretation from the point of view of predicting behaviour in actual practice unless carried out on test specimens of bulk density equal to that obtained on the road after a period of twelve months or two years under traffic. The densities of specimens of materials removed from roads can readily be determined, and when a particular mixture is compacted in the laboratory the pressure can be increased until the corresponding density is attained, assuming, of course, that compression machinery of sufficiently great capacity is available. Even if the same bulk density is obtained, however, it does not follow that the laboratory specimen is similar in all respects to the road specimen. Consolidation by steam roller or by traffic is characterized by a kneading action, under which the particles in the mixture are enabled to re-arrange themselves in dense formation far more readily than under a steady load applied only in a vertical direction. It appears likely that with some materials far more crushing of aggregate takes place when compaction is carried out by a gradually applied load than results from roller and traffic compaction.

Recognition of the essential differences between compaction by direct pressure and by the action of steam roller and traffic led to the installation of a roller compression machine in the Beckton Laboratory, and the work so far has indicated that it is likely to be a valuable method of preparing test specimens. The machine is described and illustrated in the paper. The method of operation is quite simple, and experiments with tar concrete have shown that, with a wheel sector load of 30 cwt., specimen blocks can be obtained equal in density to those obtained by the gradually applied load method using a maximum pressure of 1 ton per sq. in.—equivalent to a pressure of 180 tons on a specimen 20 in. by 9 in. Also, the density of the roller compressed blocks is more uniform, and less crushing of the aggregate takes place. The authors conclude by saying that "if work which it is hoped to carry out indicates that these results are equally true for a wide range of bituminous materials, then this method of compaction will certainly have very important claims for the consideration of those engaged in similar work and desiring to prepare large test specimens without the use of high-capacity compression machines."

Future of the Industry

OUR present view is that, in general, the cheapest therm to the consumer is to be had by a properly proportioned balance of carbonizing plant and carburetted water gas plant or complete gasification plant; and we regard the sale of coke as an all-important item in this therm cost. Mr. C. F. Broadhead, Engineer to the Metropolitan Gas Company of Melbourne, believes that the future will see wholesale adoption of complete gasification plants as the sole gas-making medium. This is but one of many radical changes he visualizes if the Gas Industry is to prosper—or, indeed, even to survive. His views are expressed in his Presidential Address to the Australian Gas Institute, which we publish in our columns to-day.

Many will disagree with these views, and many may agree; all will be thoroughly stimulated by his controversial opinions and be impressed by his breadth of outlook and his determination in adopting a courageous policy. His point about gas and coke is clear enough. He urges the Industry to become a Gas Industry, and not to fall between two stools by attempting to manufacture gas and coke—an inferior, crude fuel and a competitor of the refined gaseous energy. He maintains that the gas industry cannot afford to speak with two voices, and he argues that the money expended on the preparation of coke for the domestic market represents bad spending.

Conditions in Australia may favour this policy; but we shall have to study the position in Great Britain very carefully indeed before deciding to put no more coke on the market. We have no doubt at all, of course, that if—and allowing for varying efficiencies of application and the all-important convenience factor—heat units in gas were comparable in price with heat units in coke, domestic heating and water heating by solid fuel would go by the board. At present, however, for continuous heating coke is cheaper than gas, and the same applies to a considerable section of the continuous domestic hot water demand. Can the Industry afford to neglect this demand for solid smokeless fuel? If it does it will find a peculiar form of competition in the shape of gas made by the purveyors of this smokeless fuel. By all means let us do everything in our power to cheapen the price of gas and extend its sales, but let us make certain first that the coke we manufacture is in fact a competitor and not an ally.

Mr. Broadhead's vision of future gas service is excellent—the supply at adequate and uniform pressure of

gas which has been completely purified. We are in agreement with him when he points to the danger of regarding " purification " as the removal of sulphuretted hydrogen only—a narrow and restricted definition of purification. The necessity for more effective purification must be recognized, and we should be satisfied with nothing less than a gas completely innocuous in its effect on mains, services, meters, fittings, and appliances. In this connection the author's comments on the work of Dr. Kemmer, of Berlin, are of interest. The idea is to cool the gas by scrubbing it with chilled oil, removing benzole and all the sulphur compounds—in fact, co-ordination of the processes of condensation, washing, purification, and desiccation.

The Address is full of useful, directly expressed opinions, and to a few of these we call attention here. There is, first of all, his belief in the " outstanding merit " of copper-bearing steels for gasholder plating. Then, he leaves no one in doubt of his preference for cast or spun iron, as distinct from steel, for mains. To quote his own words, " we would be well advised to stick to the cast or spun pipe for reticulation purposes, for, after all, the cost of the installation is not a true gauge of the position." As to electrolytic corrosion, he pins his faith largely to drainage bonds, believing that the unpopularity of this system in Europe " is due to reports of the dire results following its haphazard employment in the United States." On the question of calorific value, having pointed to the fact that in Great Britain 75% of the gas supplied is in the region of 500 B.Th.U. per c.ft., he maintains that it would have been to the great advantage of the Gas Industry as a whole and to its customers if the calorific value had been fixed by law at this figure.

A Suggestive Address

We like Mr. Broadhead's insistence on the desirability of having mains and services of ample capacity, gas at adequate pressure, and individual appliance governors. He states that " the saving to the consumer would in a very short time compensate for the additional cost of the appliance governor." This, however, is not our conception of the functioning of a governor. It is not a " gas economizer; " it is an appliance which will ensure at all times maximum efficiency in use of the appliance, and hence always give the consumer satisfactory service. We like, too, the author's insistence on the importance of the sales organization of any and every gas undertaking. He observes: " Contrasted with the technical and secretarial sections, the sales side of the Gas Industry has been grossly neglected, and it can only be resuscitated in large undertakings by complete re-organization under the direction of a third executive who should be given the same freedom in the direction of his department as is now allowed present executive officers. The position of small undertakings in relation to sales organization is more difficult, but it is just as certain that radical reformation is necessary, and could be made to pay exceedingly well. The trouble appears to be in the dearth of suitably trained men." He regards the sales organization of the electrical industry as vastly superior to that of the Gas Industry.

We conclude our pointer to Mr. Broadhead's Address by the following quotation: " To raise our standard of efficiency to a height that would enable us to face the future with confidence we should, within the next twenty-five years, replace our manufacturing and purifying plant with modern equipment designed to produce one form of heat only—gas—entirely free from corrosive properties before and after combustion, so reinforce our distributing system that an adequate head of pressure exists at all times at the appliance, and elevate the sales department to a status in keeping with its importance. In the Industry there exists, fortunately, an untapped reserve of strength accumulated from long experience, which, allied to the adoption of a clearly defined line of action in the direction of courageous and complete modernization of our methods, would dispel any doubt whatever as to the continued prosperity of gas."

The Printed Word

In spite of the fact that one does at rare intervals find a contrary view expressed, there is at this time of day very general agreement that advertising pays, though even now some of those who believe that it pays are not alive to its full value. It is hard to understand why this failure to appreciate the full importance of advertising in the Press should exist in any quarter, in face of all the evidence to the contrary that is forthcoming. " Newspapers are the eyes and ears of society. Because it reaches more people than any other medium, the newspaper is the means through which we should tell our story." These words are from a paper which Mr. Morse Dellplain submitted to the American Gas Association conference, and the argument, as applied to our Industry, may be pursued a little farther: " Local advertising—advertising that brings home to the consumer the fact that the utility truly is a part of his community, and usually one of the largest taxpayers in it—is vital to the Industry. This advertising should emphasize particularly the service rendered and the desire of the company truly to meet the demands of the community; demands not only for therms of gas, but also for the additional services for which the customer pays in his monthly bill. . . . The breaking-down of initial resistance to a new appliance through persistent newspaper advertising greatly reduces the ultimate sales cost. You will find also that the former customer who may have had to give up the use of gas during the past few years is still reading his local newspaper. His newspaper is one of the last of the necessities which he will surrender. If we are to regain the load that will come from re-connected services, we must, among other things, continue to tell our story through the local paper."

Advertising Coal

Last Friday's *Evening Standard* contained an account of a not very serious outbreak of fire in the basement of the Strand Corner House. The fire occurred at breakfast time, and there were dense volumes of smoke; but, from the point of view of the general public, interest in the published description was probably largely in the evidence afforded of the marvellous organization of Messrs. J. Lyons & Co. For ourselves, we were mainly concerned with another equally convincing paragraph by our contemporary, which was as follows: " At 10.30 a.m., while the firemen were still in the building, the kitchen staff, men and women alike, returned and started to prepare the luncheon by candle-light, before the electric plant started working. *Cooking activities were not interfered with, because in modern restaurant kitchens most of it is done by steam and gas.*"

Speaking of smoke reminds us of an announcement in the Press a few days ago that Mr. Le Mesurier, Publicity Manager of the Coal Utilization Council, was to give an address on " How Coal is to be Advertised " to the Coal Industry Council at luncheon last Monday. We were not present at the luncheon, but gather that it was the intention of the speaker to describe the Council's campaign for the co-operative advertising of coal during the current year. It seems that there are to be four specialized advertising campaigns, an arrangement which has imposed the necessity of finding a link to join the campaigns together, so as to get their full cumulative effect. The *Newspaper World* explains: " That link has been provided by a symbol which will appear on every single bit of the coal advertising. In time this symbol will mean ' coal ' to the man in the street, just as clearly as the figure of Johnny Walker now means whisky to him." Again: " The only way to make it satisfactory to people to burn more coal is by educating them up to the improvements made in the methods of burning it."

We are curious about this symbol, which in time will mean coal; but that is by the way. The lesson to be taken to heart by our Industry is that this campaign calls for increased propaganda on behalf of gas, accompanied by cymbals—pardon, symbols—if need be.

PERSONAL

RETIREMENT OF MR. W. E. PRICE.

After fifty-seven years' service with the Hampton Court Gas Company, Mr. W. E. Price, on Dec. 31 last, retired from his position of Managing Director.

It was in 1876 that Mr. Price joined the Company as Junior Clerk. He was articled to his father, Mr. E. Price, who built the works in 1852. Mr. W. E. Price was appointed Engineer and Manager in 1887, and was elected Managing Director in 1922. The make of gas in 1887 was 87 millions; last year 500 million c.ft. was the output. During that period the works were entirely re-built and enlarged under his direction.

Mr. Price was elected a member of Southern Association of Gas Engineers and Managers in 1870, and is the oldest member. He held the office of Hon. Secretary from 1910 to 1913 and was President in 1902. He was instrumental with others in the foundation of the British Commercial Gas Association in 1911, was elected Hon. Secretary of the National Gas Council on its foundation in 1916, an office he still holds, and was elected Hon. Secretary of the Institution of Gas Engineers in 1913, and has seen nineteen Presidents through the Chair.

An Associate Member of the Institution of Civil Engineers, Mr. Price was one of the first inventors of the slot gas meter—before gas undertakings would consider the proposal to sell gas in pennyworths.

Our readers will join us in congratulating Mr. Price on his long and successful service and in wishing him all happiness in his retirement.

* * *

Mr. CONRAD T. PRICE, nephew of Mr. W. E. Price, has been appointed Engineer and Manager to the Hampton Court Gas Company—the third generation to occupy the position.

As a mark of esteem on the completion of twenty-five years as Engineer and Manager of the Vale of Leven Gas Company, Ltd., Mr. JOHN LANG has been presented by the Company with a mahogany grandmother clock. The Directors met at the Gas-Works House, and Mr. Thomas B. Stirling, Chairman of the Company, in making the presentation, spoke highly of Mr. Lang's many years of faithful service. The employees also wished to honour Mr. Lang, and at a gathering held in the Offices of the Company they presented him with a mahogany barometer of Chippendale design. The gift was handed over by Mr. James Scullion, the oldest employee present.

* * *

Our readers will be glad to hear that Mr. F. C. TILLEY, a Director of Messrs. Tilley Bros., Ltd., is making good progress following an operation for appendicitis.

* * *

Mr. W. F. RODGER, M.Inst.Gas E., recently Manager of Messrs. E. Cockey & Sons, Ltd., has joined the staff of Messrs. R. & J. Dempster, Ltd., of Manchester.

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The Stockport Gas Committee have appointed Mr. R. L. GREAVES, Assistant Works Superintendent to the Wolverhampton Gas Company, as Assistant Gas Engineer and Manager in succession to Mr. J. E. Stanier, who has obtained a similar position with Stoke-on-Trent Corporation.

* * *

Prof. Sir LEONARD HILL, M.B., F.R.S., has been appointed a Director of Radiation Ltd. in place of the late Sir Gilbert Vyle, K.B.E.

OBITUARY

JAMES KENNEDY—A GREAT PIONEER.

The death on Sept. 30, 1933, of Mr. James Kennedy, Manager of the Greymouth Municipal Gas-Works, removed one of the best-known and most popular figures in the Greymouth community, and one who played a very important part in the civic interests of the town for nearly half a century. Although his health had been for some time failing, Mr. Kennedy had stuck to his post right to the end, and, as he would have desired, he died in harness. It is forty-five and a half years since he took over the Managership of the Greymouth Gas-Works, and throughout the intervening period the service under his able control steadily developed.

The late Mr. James Kennedy.

Born on May 8, 1855, in Brompton, London, the late Mr. Kennedy was the son of a Librarian of the British Museum, and in his youthful years there he made the acquaintance of the Industry with which he was to remain identified for his lifetime. On arriving, at the age of twenty years, in New Zealand, he was first engaged for three years on the staff of the Christchurch Gas Company, and in 1881 he took up a position on the gas-works at Invercargill. In the year 1888 he was chosen by the Greymouth Gas Company as the Manager for its works, which he developed very successfully during the ensuing thirteen years, until the service was taken over in 1901 by the municipality, the sum paid to the Company for the installation being £20,000. It is worthy of note that under Mr. Kennedy's energetic policy of development the Company was able to enjoy dividends as high as 20% per annum, while the Borough, since taking over the service, has recouped itself fivefold in revenue alone, having, in addition, a plant to-day that is several times as valuable as that which was taken over from the original owners. It is estimated that more than £100,000 has been obtained by the Borough Council from the profits of the gas-works for the relief of the ratepayers, in addition to the payment of interest and sinking fund on loans.

Deceased rightly enjoyed the reputation of being the Father of the Gas Industry in New Zealand. He was a foundation member of the New Zealand Gas Institute, and at their Annual Meetings his opinions on all matters pertaining to the Industry were greatly sought after. His sons Mr. Kennedy sent to the leading gas establishments of England, and just as he was the oldest Gas Manager for the Dominion, his son, Mr. Matthew J. Kennedy, General Manager and Secretary of the Wellington Gas Company, has held a managerial position in the Industry for the second longest term of the managers of the country—namely, for thirty-five years—while another son, Mr. Frank Kennedy, who has been associated with leading English gas firms, is now Sales Manager for the Wellington Gas Company, one of the most successful gas services in New Zealand. For several other gas-works the advice of the late Mr. Kennedy was invoked, notably by the Hokitika Gas Company. He was a Director of the Greymouth Dispatch Foundry, and interested himself in numerous public undertakings.

CORRESPONDENCE

Preparation of Coke.

SIR,—With reference to the very interesting contribution by Mr. H. Singleton, Engineer and General Manager of the Huddersfield Corporation Gas Department, included in your report of the annual meeting of the Yorkshire Junior Gas Association in the "JOURNAL" of Nov. 22 last, it may be of interest to mention that his experiments in methods of reducing the moisture content of coke follow very much on the lines of our actual practice at Beckton, and our experience supports his conclusions.

We have actually adopted the principle of storing, in the retort house bunkers, the unscreened coke as delivered from the hot coke conveyors, and therefore comprising all grades from breeze to large coke. Our theory in adopting this practice was the same as Mr. Singleton's—viz., that the heat in the larger sizes would assist in driving off the excess moisture from the smaller grades. Normally the mixture remains in the bunker for about eight hours, being eventually transferred to the central screening and grading plant or to the stock heaps, ungraded, to await demand.

In the case of the coke ovens at Beckton, the coke, pushed from the oven to the coke car, is quenched by sprays under the tower and subsequently spread on the coke bench. The degree of quenching is not left to the judgment of the car driver, but is, in fact, carried out by a quantity of water automatically controlled and prearranged to suit the carbonizing conditions obtaining at the time. Analyses bear out Mr. Singleton's observations in that the average moisture content for each grade is low—viz., under 2% for large coke, under 5% for 2 in.-1½ in., and under 8% for 1½ in.-¾ in. grade.

It so happens that I am able, from practical experience, to comment upon the method of drying wet coke by means of hot waste gases from the retort bench, which Mr. Singleton describes. We have at Beckton an apparatus, operated on this principle, designed and installed by the works staff some five years ago. The object was to treat the nut size coke which had been passed through the washing plant for the removal of shale. The washed nuts had a very high water content—over 20%—and it was necessary to reduce this before sale, either by prolonged storage in a ventilated heap or by some quicker method.

The special drying plant referred to consists of an insulated cylindrical shell with a steel lining having a capacity of approximately 2 tons of coke nuts, fed at the top and discharged at the bottom. There is an insulated connection between the waste gas flue and the shell, louvred inlet to the lining, and a fan to draw the hot gases through the coke, discharging them into the atmosphere. Again our results confirm the findings of Mr. Singleton—the moisture being reduced to a figure as low as desired.

Yours, &c.,
R. W. HUNTER,
Engineer.

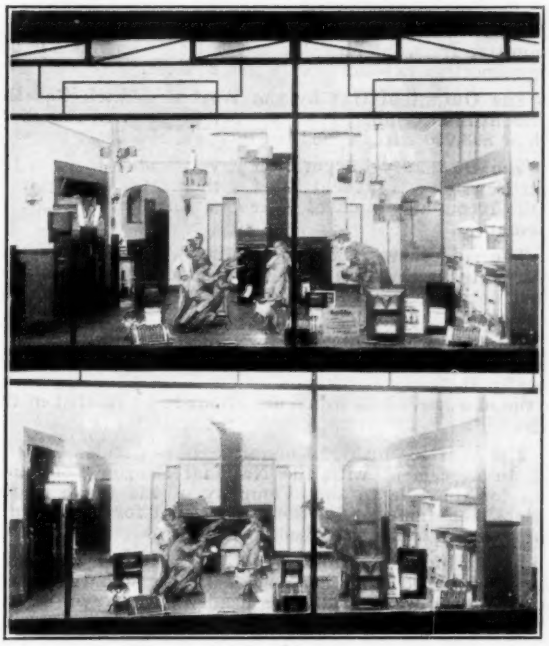
Beckton Gas-Works,
Gas Light and Coke Company,
Jan. 9, 1934.

Lighting of Showrooms.

SIR,—We have recently rebuilt our showrooms, and before this was commenced I was much concerned about providing a quiet, soft light but of ample power. In this connection I have often been impressed with many of the electricity showrooms, some of which are beautifully illuminated, and I am afraid most of our showrooms, even those of larger companies, are very poor in comparison, relying principally on multiple cluster fittings which usually provide an insufficient and broken light.

I enclose two photographs taken at 8 p.m. about a week ago. One (the upper one) was taken with concealed lighting only, the principal lights being four 6-light cluster ceiling lights behind the window with three piece chromium reflectors, four 3-light clusters with chromium reflectors in splay of the centre pylon, and three 3-light clusters over the cooker recess, together with two 3-light clusters over the counter; also lights in office and bathroom. I think you will agree that this photograph (which has not been touched up in any way) gives an effect almost as good as daylight and serves to show that proper gas illumination can give equally as good a result as, even if not better than, electricity.

The other photograph was taken with the additional illumination of several lighting fittings, and is very much inferior in consequence.



A Useful Comparison.

Owing to the angle at which the photograph was taken it does not give an effective idea of the floor space, which is 42 ft. by 24 ft.

I might mention the lighting was to my own design and the special fittings were executed by Messrs. W. Sugg & Co., Ltd.

Yours, &c.,
J. H. LOWTHER,
Manager and Secretary.

Bideford Gas and Coke Company, Ltd.,
8, The Quay, Bideford,
Jan. 2, 1934.

1934 "JOURNAL" Directory.

Page 24. FARNHAM. "Make" should be 210 millions; coke for sale, 6000 tons.

Page 30. HARROGATE. C. Bateman appointed E. & M. *vice* F. H. Robinson (now at Bishop's Stortford).

Page 36. ILFRACOMBE. R. S. Falkner appointed E. & M.

Page 50. NEYLAND. 1933 figures approx. correct.

Page 58. SALTASH. T. E. White deceased.

Page 90. PITTENWEEM. C. Carlow (from Tain) appointed E. & M.

Page 94. BALLINA. No 'phone. Make 6·7; consumers, 433; C.V., 600.

Page 98. TRALEE. 'Phone 58 and 59. C. T. Kennedy, S.; O. G. Tough, Acting E. & M. Make, 14; consumers, 721; C.V., 450; price 6s. 8d.

Page 102. GREYMOUTH, N.Z. Jas. Kennedy, E. & M., deceased.

Page 126. ELLESMERE PORT. H. W. Dean (Gas Engineer and Manager) is Public Lighting Superintendent.

THE NEWS OF THE WEEK

The Stockport Gas Committee have decided to rent premises at 34, Bramhall Lane South, Bramhall, to be used as a branch showroom.

Sanction has been Received by the Birkenhead Gas Committee from the Ministry of Health to borrow £10,000 for prospective expenditure on gas cookers.

The Output of Gas by the West Bromwich Gas Department in December, 1933, was 57,962,000 c.ft., compared with 54,893,000 c.ft. in 1932, an increase of 5·59%.

The Dewsbury Corporation have decided to light the main Dewsbury-Wakefield Road with central gas lighting, on the recommendation of their Gas Engineer, Mr. H. L. Bateman.

The Adoption of Modern Methods of gas production and selling at the Dunbar Town Council's works has resulted in an increase during the past year of 25% in the gas consumption in the district.

Tenders are Invited by the municipal authorities of Lugano, the well-known holiday resort in Southern Switzerland, for the supply and installation of the plant necessary for the new gas-works which are about to be erected in the town.

The Warrington Gas Committee have decided to enter into an agreement with the National Benzole Company, Ltd., for the sale to that Company of the whole of the benzole manufactured by the Department for three and a quarter years from Oct. 1 last.

At an Inquest at Sutton, on Jan. 1, on a man who was killed by electric shock while having a bath, it was stated that he was washing his head when his arm caught in the flex of an electric bowl fire attached to the lamp socket. The fire fell into the bath. An expert said that while the bowl was in the water the man was comparatively safe, because his body formed part of the earth, but as soon as he took the bowl fire out of the water he became a conductor and received a 200-volt shock. A verdict of "Accidental death" was recorded.

Street Lighting Experiments are being carried out with "daylight" electric lamps in North Shields—where the Corporation own the Electricity Undertaking—and a local newspaper, commenting upon this, compares the results unfavourably with those of the main thoroughfares of Whitley Bay, which, the writer states, are brilliantly illuminated. At the latter town the Local Authority owns neither gas nor electricity undertakings, and the street lighting has recently been modernized with up-to-date gas equipment on a ten years' contract.

The Society of Chemical Industry has formed a new subject group. Following a resolution passed during the Society's conference at the Public Works Congress in November last suggesting the formation of a group within the Society to cover constructional materials, steps were taken to inaugurate a section on similar lines to the existing Food, Plastics, and Chemical Engineering Groups of the Society. The Group, known as the Road and Building Materials Group, has now come into being and membership of it is rapidly increasing. Those interested in membership or wishing for further particulars should communicate with the Hon. Secretary, R. and B.M. Group at Central House, 46, Finsbury Square, E.C. 2.

Electric Light Fails in Hospital.

Gas Enables Operation to be Continued.

An urgent operation was performed by gas light in Savernake Hospital on the night of Jan. 6, when the electricity supply failed in a chain of Wiltshire villages.

Members of the staff hurried to get candles, with which the wards were temporarily lighted, and the emergency gas installation in the operating theatre enabled the surgeons to continue their operation.

Cheering Figures.

There are occasions upon which one wishes to forget one's investments, but this is not one of them. Prices have risen substantially lately, and are still on the up-grade, so that comparisons are apt to be gratifying. It is therefore with exceptional pleasure that we once more draw attention to "Mathiesons' Handbook for Investors," which is a concise record of Stock Exchange prices and dividends for ten years of selected securities. This record must in any case be invaluable as an aid to investment, but the 1934 edition (price 5s. net) may be commended, too, for the cheering effect it is likely to exercise upon those who study it. We have also received a copy of the "Investor's Pocket List of Reference Tables" (price 1s.), which is an extremely handy compilation, for the tables are real labour savers. Both these publications are by Messrs. Fredc. C. Mathieson & Sons, 16, Copthall Avenue, London, E.C. 2.

Floodlighting of Rushden Hall.

Mr. A. T. Watson, Engineer and Manager to the Rushden and Higham Ferrers District Gas Company, has sent us the accompanying photograph of Rushden Hall floodlighted by gas. The Hall was lighted by six 800 c.p. lamps and one of 500 c.p.

Gas Exhibition at Nantwich.

The Nantwich Urban District Council Gas Department, under Mr. H. Vernon, the Engineer and Manager, recently held an exhibition of gas appliances in the Town Hall, which was completely lighted by gas.

The large platform was divided into two sections—one depicting a lounge hall heated and lighted by gas, and the other a fully equipped bathroom.

Mr. H. S. Shepherd, Chairman of the Council's Gas Committee, said that in the face of trade depression and intense competition their output of gas was steadily increasing. A year before the war they produced at their works 54 million c.ft. of gas, which required 4671 tons of coal. Although seven of their large consumers had taken 6 million c.ft. less, the present output of gas had gone up to 69 million c.ft., and the consumption of coal had not been so great, the figure being 4600 tons. In the Nantwich district there were 2500 gas cookers, 540 gas fires, and 600 gas wash-boilers.

An interesting section of the exhibition was that devoted to the display of the bye-products derived from gas manufacture, while washing by means of a gas wash-boiler was another feature which attracted a great deal of attention. Demonstrations were given by Miss Groome (Messrs. Dean & Son, Ltd., Burnley), with a self-contained machine, consisting of a 10-gallon container, agitator, and wringer complete.

Alice at Bournemouth

The scene from "Alice in Wonderland" depicted above is one of a series of Christmas displays possessing distinct drawing power which were made in the Central Showrooms, Old Christchurch Road, of the Bournemouth Gas and Water Company.

The Industry Forges Ahead.

Good Publicity in South Wales.

Last week we had occasion to refer to the good publicity the Gas Industry received through the medium of the Trade and Industrial Supplements of two widely read Sheffield newspapers. Following close upon the heels of this, we are gratified to note that the Industry again receives "honourable mention" in another important industrial centre—namely, South Wales.

Gas and its multifarious applications—particularly in the industrial field—were dealt with in a very comprehensive manner in the Trade and Industrial Supplements of two respected South Wales journals—the *Western Mail and South Wales News* and the *South Wales Evening Post*—in the first instance at the hands of Mr. H. D. Madden, M.Inst.C.E., of the Cardiff Gas Light and Coke Company, and in the other by Mr. W. H. Johns, M.I.Mech.E., of the Swansea Gas Light Company.

Mr. Madden dealt with his subject on general lines, referring to the importance of the Industry from a national standpoint—in peace or war—and having regard to its sources of potential employment of labour. The railways and docks, he pointed out, benefit by the prosperity of the Industry, inasmuch as the requisite quantities of coal and general heavy stores necessary in gas-works, the outflow of residuals, and the shipments of coke, &c., provide a large amount of work for railway men and dockside workers.

Believing in the fuel which we have to offer to the public, he concluded, and its efficiency in application, and imbued with a deep desire to give the greatest service to consumers and to the general public, the great Gas Industry will go forward vigilantly and fearlessly to meet the strong competitive activities with which it has to battle.

Assistance to Manufacturers.

In his contribution, Mr. Johns referred to the continued investigation and research which have led to the production of appliances which have assisted manufacturers in further reducing production costs, and which have in some instances enabled them to make and market apparatus hitherto unknown.

Mr. Johns remarked that, notwithstanding the difficult times at present being experienced, the Swansea Company are still progressing in the sale of domestic and industrial appliances, and are providing employment for many additional workmen to cope with the demand. The Swansea Gas Light Company are one of the largest ratepaying concerns in the borough, and give constant employment to approximately 260 employees. They consume 30,000 to 40,000 tons of coal annually, which is equivalent to employing 80 colliers on full time each year.

The above-mentioned two articles, coming as they did at the advent of a year to which the Gas Industry, alike with every other industry, looks forward for increasing prosperity, should do much to stimulate a greater measure of interest in gas as the solution of some of South Wales' industrial problems during 1934.

Survey of Our National Coal Resources.

Report on an Important Nottingham and Derbyshire Seam.*

A Fuel Research Survey Paper just issued by the Department of Scientific and Industrial Research embodies the results of a physical and chemical survey of the Deep Hard Seam of the Nottingham and Derbyshire coalfield.

The moisture content is moderately high in the south, but decreases towards the north, the figures ranging from 10·9 to 2·3%. The ash content varies between 2·9 and 7·8%

* Fuel Research Survey Paper No. 30, Nottingham and Derbyshire Area Deep Hard Seam. Published by H.M. Stationery Office; price, 2s. 6d.

THE NEWS—*continued.*

in the samples examined, with an average of about 5% for the whole area. The volatile matter in the dry ash-free coal is high, 37% being the lowest figure and 43·5% the highest. The carbon content and the calorific value also increase towards the north, the former from 79·88 to 83·85% and the latter from 14,250 to 15,090 B.Th.U. per lb., in both cases expressed on the dry ash-free coal.

The sulphur content is outstandingly low, particularly in the central and southern parts of the field, where the average is 0·83%. The phosphorus and chlorides vary considerably (from 0·007 to 0·086% and 0·002 to 0·45% respectively). The ash has a relatively high fusion temperature.

The coking properties, as shown by the caking index, increases from south to north, and this is confirmed by the laboratory carbonization assay, which shows the seam to change from a non-caking to a moderately highly-caking coal.

Eighteen-Hour Electricity Failure.

Herne Bay's Plight.

For eighteen hours last Sunday—from 5 a.m. until 11 p.m.—Herne Bay was without an electricity supply, due to the cable conveying current to the town from Canterbury having fractured, as a result, it is suggested, of heavy traffic on the main Canterbury road.

The breakdown, which workmen were engaged all day in repairing, caused very considerable inconvenience. Hotels and restaurants with electric cooking equipment were severely handicapped, and many Sunday dinners could not be cooked. The cinema was unable to open, while Church services were held and hospital patients attended to by candles and lamp light. The automatic traffic light signals were, of course, also put out of action.

The fact that the shops were closed added to the difficulties of many people, who were unable to purchase candles or oil for lamps and heating stoves. Many had to spend the evening in darkness, relieved only by firelight; they were denied even the consolation of their wireless installations. The pier was closed at sunset, and hurricane lamps had to be fixed at the end as navigation lights for shipping. The local wireless relay station was put out of action.

Great inconvenience was caused in hotels and restaurants, and meals had to be cooked in some cases on oil stoves and coal fires and eaten by the light of lamps and candles.

Fortunately all the streets are lighted by gas, with the exception of the promenade, where red lamps normally used for marking road obstructions were placed along the edge of the sea front. At the Cottage Hospital, though candles and petrol lamps had to be used in the wards, the authorities had taken the wise precaution of having gas available in the operating theatre.

The "Gas Journal" Calendar for 1934.

The Simmance Calorgraph.

On p. 160, and again on p. 216, of the 1934 edition of the "GAS JOURNAL" Calendar and Directory, reference is made to the General Notification of the Gas Referees, re-issued on Aug. 31, 1930. As mentioned in a footnote on both these pages a further re-issue, with extensive revisions, was made on Nov. 15, 1933, and came into force on Jan. 1 last.

We would call the attention of our readers to the fact that the new Notification states that the Simmance Patent Calorgraph, Type R, has been approved by the Referees to provide an alternative instrument to the Sigma B.Th.U. recorder. Reference to this fact was made in the "JOURNAL" for Dec. 6, 1933, p. 711, when the alterations in the new Notification were indicated.

The Simmance Calorgraph is marketed by Messrs. Alexander Wright & Co., Ltd., of Westminster.

Colonial Gas Association

The Forty-fifth Annual General Meeting of the Colonial Gas Association, Ltd., was held at Melbourne on Oct. 4, 1933, Mr. P. C. HOLMES HUNT, M.Inst.C.E., Chairman of Directors, presiding.

The CHAIRMAN said: In regard to the revenue accounts, I will first direct your attention to the sales of gas. It is pleasing to point out that although this revenue was down by £1843, the quantity sold by the Association's Works (other than the Subsidiary Gas Undertakings) was an increase of 2·8% upon the quantity sold during the previous year. The lower revenue, therefore, was due to the reduced prices charged for gas. Turning to the expenditure side of the account, the first item, "Coal and Purifying Materials," showed a good reduction of £4925. This, however, is not all extra profit, as allowance must be made for the lower yields of residuals. General administration charges are lower by £1688, but last year's figures included heavy legal costs in connection with the case regarding the Financial Emergency Act of Victoria. Nevertheless, there is a pleasing reduction under this heading.

Interim dividends were paid in April last, and the final dividend recommended on the ordinary shares will make 6% for the year.

During the year we made substantial additions to our staff of cookery demonstrators and salesmen, especially in Victoria. A number of successful demonstrations were held in the suburban districts of Melbourne served by the Association's Works. These demonstrations were followed up with satisfactory results by our staff of trained salesmen, in bringing before householders and others the possibilities of utilizing gas to more advantage, and making many sales of appliances.

The Directors' Report has drawn your attention to the fact that the results of the trading by our Subsidiary Gas Undertakings in New South Wales and Queensland have been a further decrease in the sales of gas by 3·2%. On the whole, our Subsidiary Undertakings dealing with bye-products have continued to show satisfactory results, although those dealing with tar, which show up better than for the previous year, are still feeling the effects of the depression and competition from imported bitumen.

A development of importance took place during the year. We were approached by promoters of a Company to be formed for the manufacture in Brisbane of liquid and solid carbon dioxide, for the lease of an area on a site owned by the Association at South Brisbane. The manufacture of this new refrigerant had been receiving prior attention from us, and as the operations of the factory could be conveniently linked up with our Ammonia Works situated on another portion of the site referred to, we decided, after a full investigation, that it would be desirable to become associated with the Company about to be formed. The Directors were influenced in their decision by the fact that the climate and industries of Queensland offered particular attractions for the establishment of a factory to manufacture these products.

The Company is installing a plant to operate under the Carba Patents, the purchase of which plant carried with it the rights for Queensland of what is universally recognized as the leading process. The Company, therefore, is ensured the benefit of association with world-wide kindred activities, and is able to work closely with the owners of the Patent Rights in Australia, the Carba Dry Ice (Australia) Limited, whose principal works are in Melbourne.

The carbon dioxide gas, which is subsequently liquefied and solidified, in the latter form being known as "Dry-Ice," is best manufactured from a gas-works bye-product—coke—and is thus closely allied with our general operations.

We are satisfied that there is a large potential market for solid carbon dioxide, and shareholders will be interested to know that the factories in England this summer, although their output is substantial, have been unable to manufacture sufficient to meet the full demand, dry ice being actually imported from the Continent.

The use of solid carbon dioxide as a refrigerant has indeed, during the past few years, made phenomenal strides.

The resolution for the adoption of the report and accounts having been carried, the CHAIRMAN moved—

"(*a*) That a dividend at the rate of 8% per annum (less interim dividend of 4% for the half-year ended Dec. 31, 1932) be paid on the preference shares; and

(*b*) That a dividend at the rate of 6% per annum (less interim dividend of 3% for the half-year ended Dec. 31, 1932) be paid on the ordinary shares; and

(*c*) That the balance (approximately £23,600) be carried forward to the next account."

Sir STEPHEN MORRELL, K.B., seconded the resolution, which was carried unanimously.

A Pressure Recorder for Waterless Holders

The supervision of waterless gasholders is best accomplished by measuring and recording the pressure at the level of the piston. It is useless to measure the pressure at the base of the holder, as this will be less when the piston is high than it is when the piston is low. The up-thrust or buoyant effect of the gas on the under side of the pistol will, of course, vary with the specific gravity of the gas and the height of the holder. That is to say, the lighter the gas and the higher the piston the greater will be the thrust under the latter. This is shown in the curve fig. 1.

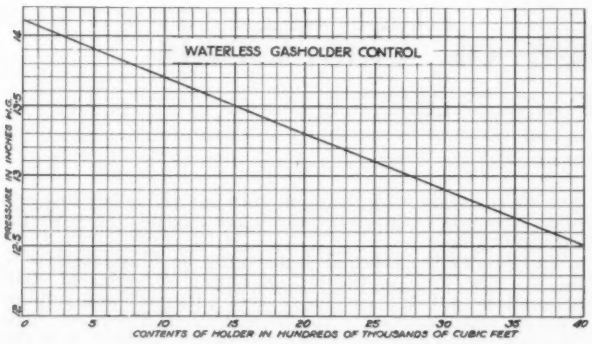


Fig. 1.

In order to measure the pressure actually at the piston level some engineers place a pressure recorder on the piston—*i.e.*, inside the holder. If the charts from this recorder are examined it will be seen that under normal conditions the pressure remains constant to within 2-tenths W.G., rising by this amount when the holder is filling and falling by this amount when the holder is emptying. This variation in pressure is due to the friction between the piston and the holder shell.

If a recorder is installed at the base of the holder it will be observed that the variations from normal pressure are approximately 2 in. W.G. in a holder, say, 270 ft. high, filled with coke oven gas having a specific gravity of 0·5 (air = 1). See fig. 1.

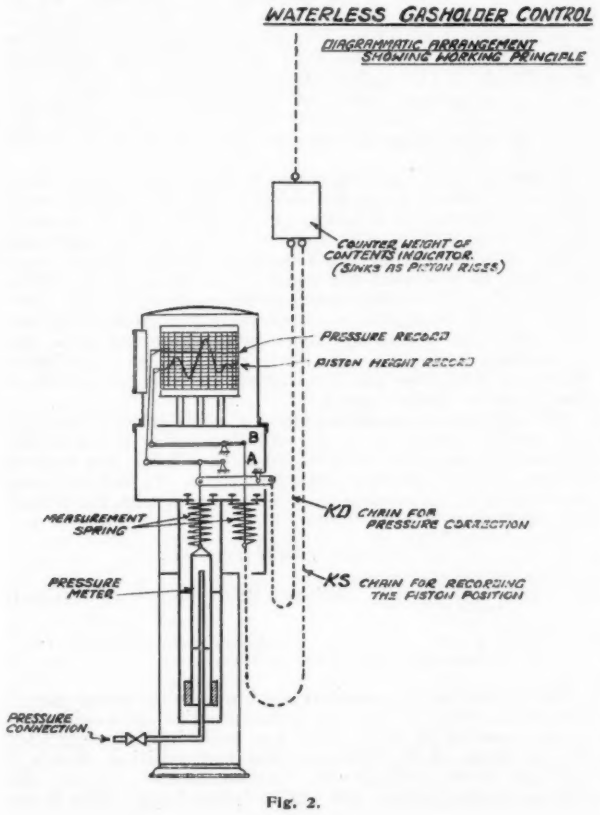


Fig. 2.

Returning now to the pressure at the level of the piston, while pressure variations do not amount to more than 2-tenths W.G., the piston may be assumed to be quite level and to be working without binding. Any increase in the pressure variation should be immediately noted, and, if of more than momentary duration, action should be taken to locate and remove the cause of binding.

Obviously, small variations in pressure could not be ascertained if the pressure is taken at the base of the holder, as large normal variations exist here due to the varying position of the piston.

The easiest way out, therefore, appears to be to place the pressure recorder on the piston itself. This method, however, has serious disadvantages, as the recorder is not readily accessible for inspection, and, more important still,

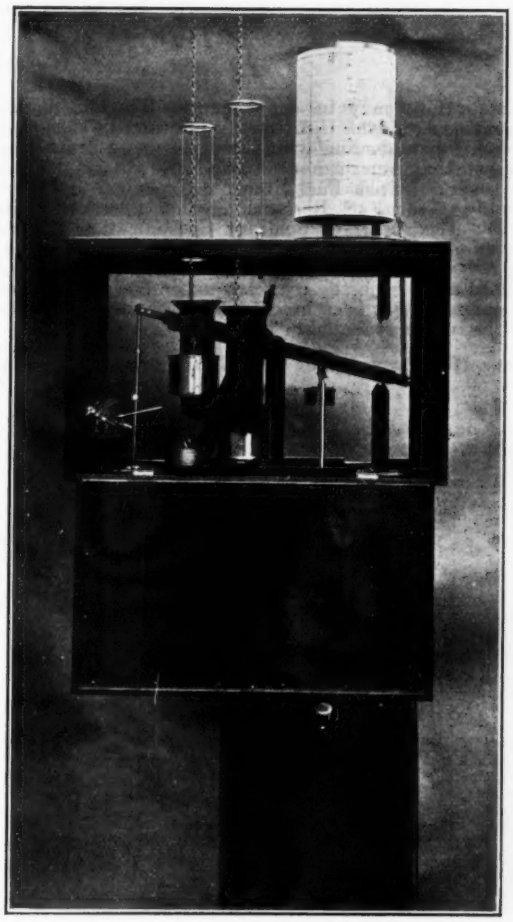


Fig. 3.

it cannot be equipped with automatic electric alarm contacts to operate a syren or visible signal if the high or low pressure limits are exceeded. Moreover, in order to ascertain whether a state of danger exists the inspector must enter the danger zone—*i.e.*, the space above the piston.

The solution is to measure the pressure at the base of the holder, and to arrange the equipment in such a way that the varying thrust under the piston is automatically allowed for. In this way the condition of affairs at the piston level is known from the base of the holder, and the recorder may easily be equipped with alarm contacts which will operate a syren or other signal device. The signal is designed so that once set in operation it continues to work until reset by hand. This ensures that momentary faults receive due attention.

The operation of the instrument will be seen from fig. 2. The counter-weight attached to the contents indicator of the holder is equipped with two light corrosion-resisting chains KD and KS which are attached respectively to pen gear A and pen gear B of the recorder. Pen gear A is operated in the conventional manner by a bell type pressure recording mechanism, but instead of the true pressure

at the base of the holder being shown, rather less is shown. The amount of the deduction from the true pressure at the base of the holder varies with the weight of the chain KD which falls into a suitable chain bunker on the pen arm of the recorder. Thus, with the piston at the top of its stroke, the weight of the contents indicator will be in its lowest position and the amount of chain in the bunker will be the maximum. Obviously, therefore, it is perfectly simple to arrange matters so that the weight of the chain exactly cancels out the upthrust, thus enabling the recorder to show, not the pressure at the base of the holder, but the pressure at the level of the piston.

Chain KS operates a pen through a pivotted lever and shows the piston position. Piston position and pressure at the piston level are recorded on the same chart; thus any extraordinary pressure variation will be at once related to the exact piston height where the variation occurred.

The pressure recorder portion of the instrument is designed so that only normal pressure variations occupy chart space. That is to say, the scale is suppressed below and above the safe limit pressures, although the instrument is naturally designed to withstand the maximum pressure encountered at any time.

Fig. 3 shows the appearance of the recorder, which is fully patented and is sold by Messrs. Walker, Crosweller, & Co., Ltd., 20, Queen Elizabeth Street, London, S.E. 1.

Assessing the Value of Gas Coals

By R. A. MOTT, M.Sc., F.I.C.

(*Concluded from p. 34.*)

These results may be supplemented by tests made on different coals by the U.S. Bureau of Mines in their recent series of papers dealing with the carbonizing properties of representative American coals, and by the results taken from several British Fuel Research Technical and Survey Papers. At the Fuel Research Station (Technical Paper No. 24: The Assay of Coal for Carbonization Purposes, Correlation with Coal Gas Manufacture, 1930) the Gray-King assay test has been modified to give similar thermal yields to those from the coals treated in horizontal retorts. The same test has been used by the U.S. Bureau of Mines with the results recorded in Table II.

TABLE II.—*Thermal Yields from Different Coals in Gray King High-Temperature Assay.*

BRITISH COALS.

Coal.	Carbon. Dry, Ash and Sulphur Free.	Hydrogen. Dry, Ash and Sulphur Free.	Gray-King Assay.		Vertical Retorts with 5% Steam.		
			Therms per Ton of Dry, Ash and Sulphur Free Coal.	Cal. Val. of Gas. B.Th.U. per C.Ft.	Therms per Ton of Dry, Ash and Sulphur Free Coal.	Cal. Val. of Gas. B.Th.U. per C.Ft.	Equivalent Therms of Gas of 475 B.Th.U./C.Ft.
Shafton (Yorks.)	83·1	5·36	77·9	600	..	..	..
Ravine (Lancs.)	84·9	5·40	76·1	590	84·2	495	87·6
Kinneil (Scot.)	85·1	5·25	79·3	602	90·4	477	90·5
Barnsley (Yorks.)	85·6	5·35	78·3	592	..	..	..
Parkfield (Somerset)	86·0	5·48	83·3	578	91·2	511	98·0
Silkstone (Yorks.)	86·7	5·54	80·7	669	..	..	..
Arley (Lancs.)	87·0	5·28	74·4	585	87·8	502	92·7
Parkgate (Yorks.)	87·3	5·56	80·9	597	87·0	524	96·0
Silkstone (Yorks.)	88·4	5·61	77·8	643	..	..	..
Wearmouth (Durham)	88·5?	?	77·4?	590	..	..	..
Holmside (Durham)	88·9	5·48	65·3	577	76·0	524	83·9

AMERICAN COALS.

Coal.	Carbon. Dry, Ash and Sulphur Free.	Hydrogen. Dry, Ash and Sulphur Free.	Gray-King Assay.	
			Therms per Ton of Dry, Ash and Sulphur Free Coal.	Cal. Val. B.Th.U. per C.Ft.
No. 6, Franklin Co., Ill.	83·1	5·36	70·9	566
Blackcreek, Walker Co, Ala.	85·1	5·78	82·2	633
Elkhorn, Letcher Co., Ky.	85·2	6·14	82·7	645
Pittsburgh, Fayette Co., Pa.	86·4	5·56	76·3	644
Pittsburgh, Allegheny Co., Pa.	86·8	5·77	73·7	630
Mary Lee, Jefferson Co., Ala.	87·9	5·34	76·0	601
Davis, Garrett Co, Md.	89·2	5·5	62·9	553

The American results show the drop in both thermal yield and calorific value for coals of low and high rank. The British coals give the drops in thermal yields for low and high rank coals, but there is no regular change with the calorific value.

The results for thermal yields may be illustrated as in fig. 3. The drop in thermal yield for all series of coals between 86 and 89% carbon content (dry, ash and sulphur free) is most marked. The British and American coals give maximum thermal yields at 85-86% carbon, but the Canadian coals at a rather lower carbon content. From these results it may be concluded that the good gas coals are within the range 84 to 87% carbon content (dry, ash and sulphur free), the best of all being within the range 85-86% carbon.

The range of carbon content given for maximum thermal yield corresponds with the reputations of different seams of coal in gas making. For example the Hutton Seam, Durham, near the coast where it is a common constituent of "Wear Special Mixtures" has a carbon content of 86-87·4%, Parkgate seam bright coal (South Yorkshire) mostly of 85 to 87% carbon, and Barnsley seam bright coal of 83 to 85% carbon, all on a dry, ash and sulphur free basis. Other well-known gas coals are Cockshead, North Staffordshire (C 84·9%), and Black Shale, Derbyshire (C 84·8%).

These conclusions refer to the manufacture of gas in horizontal retorts. When steaming is practised, as in vertical retorts, or dilution with water gas is desired, a high calorific value of the straight gas allows more dilution with water gas. In the Fuel Research Board steaming tests (Table II.) the calorific value of the gas increases with increase in carbon content of the coal to 87%. It would seem, therefore, that coals of 86-87% carbon content are the best when addition of water gas is to be made to the straight coal gas.

It will be noted that, to compare these figures with those previously recorded for dry, ash-free coal in different counties, a reduction of 1 to 2% of carbon should be made—say, 85·5 to 82·75% dry, ash-free basis for the good gas coals. Assuming that the records previously given could be taken to represent the usual range of coals, it will be obvious that the higher ranks of the coals in Northumberland, North Staffordshire, Derbyshire, and Nottinghamshire coalfields would be chosen as the best gas coals, but in Durham it would be the lower range of those available. In South Yorkshire and Lancashire, coals in the middle of the range would be chosen.

The equivalent calorific values of coals selected as good gas-making coals may be shown by assuming that the dry, ash and sulphur free coal would have a hydrogen content of 5·5% and a nitrogen content of 1·7%. In the dry, ash-free coal 1·5% of sulphur may be assumed, with the following results:

Composition of Good Gas Coals.

Dry, ash and sulphur free—
Carbon, 83°/₀ to 87°/₀. Hydrogen, 5·5°/₀. Calorific value, 14,950 to 15,600 B.Th.U.

Dry, ash free—
Carbon, 82·8°/₀ to 85·6°/₀. Hydrogen, 5·4°/₀. Sulphur, 1·5°/₀. Calorific value, 14,750 to 15,350 B.Th.U.

Since dilution of straight coal gas with water gas is generally adopted in gas-making practice, it would seem to be possible to place good gas coals into three grades, giving those of highest rank the first position, Grade I. Carbon 87-86%, Grade II. Carbon 86-85%, Grade III. Carbon 85-84% (dry, ash and sulphur free). This is not

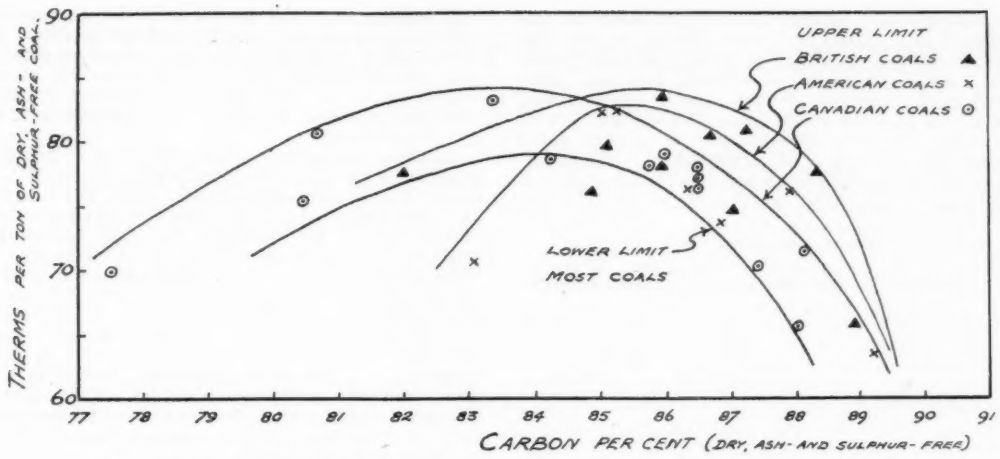


FIG. 3.—RELATIONSHIP BETWEEN THE RANK OF COAL AND ITS GAS-MAKING POWER.

entirely justified, for the carbon content alone is not sufficient to classify the coals. In general a high hydrogen content seems to be advantageous, the Arley coal for example giving a lower yield than the " normal " because of a low hydrogen content. Since an increase in the hydrogen content influences the calorific value more than the same increase in carbon content, the calorific value of the pure coal might be used as a basis for classification, and the coals of over 15,000 B.Th.U. per lb. (dry, ash-free) would be the most useful gas coals.

It should be pointed out that the comparisons made in this article have been mainly for analyses corrected to a dry, ash and sulphur free basis, for the coals varied in purity considerably, the sulphur content alone varying from 0·6 to 3·8% (dry, ash-free basis) in the list of British coals in Table II. A correction for sulphur as such is not entirely justified, since sulphur over, say, 1% is present as pyrites and it is the pyrites which should be eliminated to obtain a figure for pure coal. Similarly the ash content of a coal is lower than the mineral matter present in the coal which loses water of constitution in being converted into ash. Considerable attention has recently been given to the form in which ultimate analyses and calorific values are " corrected " to a pure coal basis, and the position is gradually being clarified. The results graphed in fig. 3 are so suggestive even on the unsatisfactory basis used that even more satisfactory results should be obtained when a better pure coal basis has been used. The writer suggests that the results here reported are sufficiently notable for the Gas Industry, as well as those concerned with the production of coals, to give the matter careful attention.

Significance of Ash and Moisture in Gas Coals.

No assessment of the value of gas coals would be complete without consideration being given to their purity in commercial consignments. A gas maker requires as much pure coal as possible, and the presence of moisture and ash reduces this, as does an undue amount of pyrites, which also increases the cost of purification of the gas from hydrogen sulphide. Preference for low sulphur coals could be shown most clearly by allowing bonuses for sulphur contents in the air dried coal of less than, say, (1) 1·75%, (2) 1·25%.

A gas engineer sometimes considers ash to be of equal negative value as inerts, but this is far from being correct, and it is worth while analyzing the position carefully to provide a more exact basis.

In comparing the effect of moisture and ash in gas-works practice the comparison may be restricted to the relative behaviour at the gas-works, for 1% each of moisture and ash are of equal effect in increasing the transport costs where both have been retained in the coal after preparation at a colliery. It must be remembered, however, that moisture in coal can and does arise by absorption during rainfall, and exceptional moisture contents can usually be traced to this source.

Thermal Losses during Carbonization.—In a horizontal retort " ash " passes right through the carbonization process, any volatile products being heated to the temperature of the gases leaving the retort while the residue is heated to, say, 1000° C. Moisture, on the other hand, is all evaporated at 100° C., and is superheated to the temperature of the exit gases (say, 650° C.) before leaving the retort.

In a vertical retort " ash " behaves the same as in a horizontal retort except that the volatile products leave at a lower temperature (say, 200° C.). Moisture is evaporated partly by the sensible heat of the exit gases so that direct heat is not necessarily required to remove it; only in so far as the heat abstracted from the distillation gases is not given up to the incoming coal itself can the removal of moisture be considered to require direct heat from the setting. On account of the low thermal head, the heat exchange from the distillation gases to the cold coal could not be very efficient, so that it may be assumed that only half of the heat required to evaporate the moisture is abstracted from the setting, the remainder being derived from the waste heat of the distillation gases.

In calculating the heat absorbed in " carbonizing " the ash in the retort, 1% of ash must not be rated so highly as 1% of coal on account of the lower specific heat of ash (say, 0·25) compared with that of coke (say, 0·38), and because of the smaller amount of volatile products from " ash." Plevin, for example (" Gas Journal," Dec. 4, 1929), has shown that even dirt of 78·9% ash content produces about 4500 c.ft. of " gas " per ton. Making some allowance for volatile products, the heat necessary to " carbonize " 1% of ash is about 60% of that necessary to carbonize 1% of coal in horizontal retorts, and 75% of that necessary in vertical retorts.

Horizontal Retorts.

Ash.—Hardie's figure (Journ. Inst. Fuel, 1927-28, Vol. I., p. 1) of 3 cwt. of coke (12,500 B.Th.U. per lb.) required to heat the retorts and 1% of breeze (10,000 B.Th.U. per lb.) required for steam production gives a total of 5,320,000 B.Th.U. required to carbonize 1 ton of coal, or 53,200 B.Th.U. per 1% of coal. Taking 60% of this for 1% of ash, each 1% of ash per ton of coal requires 31,700 B.Th.U. to " carbonize " it in horizontal retorts.

Moisture.—Each 1% of moisture (22·4 lbs.) is evaporated and superheated to 650° C. (say, 1200° F.) requiring

$$22{\cdot}4 \left\{ (212\text{-}60) + 970 + 0{\cdot}48 \times (1200\text{-}212) \right\} = 35{,}800 \text{ B.Th.U.}$$

Vertical Retorts.

Ash.—Hardie's figure (*loc. cit.*) of 2·62 cwt. of coke used to heat the retorts gives a total of 3,668,000 B.Th.U. per ton of coal carbonized, or 36,680 B.Th.U. per 1% of coal.

Taking 75% of this for 1% of ash, each 1% of ash per ton of coal requires 27,700 B.Th.U. to " carbonize " it in vertical retorts.

Moisture.—Each 1% of moisture is evaporated at 212° F.

Heat required $= 22{\cdot}4 \left\{ (212\text{-}60) + 970 \right\} = 25{,}300$ B.Th.U.

Half of this only may be debited to the setting = 12,650 B.Th.U.

Losses After Carbonization.

On leaving the retorts the only further effect of the moisture is in increasing the cooling surface required and in diluting the liquor. Both of these results are small for 1% of moisture and can be neglected in a simple comparison.

On leaving the retorts each 1% of ash in the coal amounts to nearly 1·5% of ash in the coke. Taking the figure of 40% of water gas on the total make of gas, as recorded in the official reports of the working of several of the large London gas-works, about 3·3 cwt. of coke are used per ton of coal carbonized for making carburetted water gas. This, together with 2·6-3 cwt. of coke used for heating the re-

torts, gives about 6 cwt. of coke used in producers at gas-works per ton of coal carbonized. The clinker, or pan ash, from the producers contains from 10 to 50% of coke ("The Cleaning of Coal," Chapman and Mott, London, 1930, p. 460). Taking an average of 25% coke in the pan ash, each 1% of ash in coal (or 1·45% in coke) gives 13·3 lbs. of pan ash containing 3·3 lbs. of coke, with a calorific value of, say, 10,000 B.Th.U., a loss of 33,000 B.Th.U. (In addition the pan ash may cost about 4s. per ton for disposal, carting, and tipping, or 0·28d. for 13·3 lbs.)

Total Losses.

The final comparison of moisture and ash therefore gives:

—	B.Th.U. per 22·4 Lbs. in—	
	Horizontals.	Verticals.
1% of moisture—		
Heat required for "carbonization" .	35,800	12,650
1% of ash—		
Heat required for "carbonization" .	31,700	27,700
Heat lost in pan ash.	33,000	33,000
Total	64,700	60,700

The heat required to "carbonize" moisture and ash in horizontal retorts is therefore approximately the same, but in vertical retorts at least twice as much heat is required for ash as for moisture. The loss of coke in pan ash varies with the amount of steaming of retorts, the amount of carburetted water gas made, and the design of the producers, and consequently the loss of heat due to removal of coke with the pan ash will vary for different plants. The figures given above probably represent a fair average, so that it may be concluded that, as a diluent, 2% of moisture is equivalent to 1% of ash for horizontal retorts, but, in verticals, each 1% of ash may be equivalent to as much as 5% of moisture.

In this comparison no consideration is given to the remaining 8 cwt. of coke (containing about 1½% of ash for each 1% ash in the coal) which is sold, but it is certain that the ash in the coke is prejudicial to its extended use, and certain losses—for example, loss of combustible matter with the ash or clinker—will be found by the coke user. Without attempting to put a thermal or financial equivalent on the ash in the coke sold it may be held more than to counterbalance the effect of moisture in diluting the liquor.

From this discussion it may be concluded that freedom from ash is of much greater importance than freedom from moisture, or, put in another way, reduction of ash is of more importance than reduction of moisture. Certain charging machines, however, cannot deal readily with coal of more than low moisture content, and in such cases low moisture coal is essential.

The Gas Industry could play its part in encouraging the production of coals of lower ash and moisture content by applying suitable bonuses for coals with lower ash and moisture contents than agreed standards. Assuming that classification of gas coals was made on the basis of rank as previously discussed, allowances would have to be made for the commercial purity of the consignments supplied. A reasonable basis would be to reduce the price of "pure coal" by 1% for each 1% of moisture and by, say, 1½% for each 1% of ash. This would give encouragement for reduction of ash and conform to the fact that reduction of 1% of ash usually requires the removal of 1½% of mineral matter.

IN CONTINENTAL COUNTRIES - - -

Abstract Translations from the Technical Press of France and Germany.

THE COLD-WARM DRY PURIFICATION PROCESS.

Purification forms the subject of a paper by A. Pott, H. Broche, and H. Thomas in *Glückauf*, 1933, 69, 1153-1159 (Dec. 9).

Comparison of the expense of dry purification and liquid purification shows that the total cost including capital charges is smaller in the former case than in the latter if no account is taken of revenue from recovered sulphur. The high working costs of modern liquid purification processes can be partly offset by the selling value of the recovered sulphur, which can readily be obtained in a highly refined condition. Sulphur may also be recovered from spent oxide, though this involves a cost. The result is that the net cost of liquid purification is at least as high as that of the dry process when sulphur commands a high price. If the selling value of sulphur falls, conditions favour the dry process which is therefore less sensitive to market influences. Realization of this has, in recent years, encouraged development work in connection with the dry purification process. The problem has been attacked both from the sulphur end and from the process end. As regards the former, means have been found for extracting the sulphur and restoring the spent oxide to a condition in which it may be re-used [see "Journal," 1932, 198, 874]. Oxide costs can evidently be halved even if the extracted oxide is fouled again but once.

As regards the dry purification process, the chief drawback is the small capacity of the purifiers, due to the fact that the velocity of the gas through the boxes must not exceed 0·2 to 0·3 in. per second. Because of this, 50-75% of the cost of dry purification is represented by capital charges.

The slow speed at which revivification occurs *in situ* is the factor responsible for limiting the velocity of the gas, since absorption of sulphuretted hydrogen is very rapid and is to a large extent completed in the first box. It has been found that absorption of sulphuretted hydrogen takes place rapidly and quantitatively even at a gas velocity as high as 2 in. per second. The efficiency is but slightly affected by temperature, providing the temperature is at least 68° F. The speed of revivification is, however, greatly affected by temperature and increases with increase of temperature. At a temperature of 105°-120° F., velocities as high as 0·8 to 1 in. per second may be employed and revivification will still be complete with the normal rotation.

In view of these facts, a cold-warm process of purification is proposed. The process is so called because purification is effected in two stages at different temperatures. The gas leaving the first box is heated by passage through a heat interchanger, and is then passed through the remaining boxes. It is, of course, necessary to humidify the gas between the stages, otherwise the oxide will be dried. Heating and humidification may be effected simultaneously by the use of direct sprays of hot water There is no point in heating the gas before it enters the first box. This, indeed, is a drawback, since clogging of the oxide is likely to occur. If the gas has a relatively high content of sulphuretted hydrogen, heat may be applied at the inlet to the third box instead of at the inlet to the second box. In the cold-warm process, backward rotation is employed just as in normal practice.

The quantity of gas which can be passed through the purifiers before sulphuretted hydrogen is detectable in the outgoing gas is approximately twice as great in the cold-warm process as it is in the normal process.

The cold-warm process enables much higher gas velocities to be employed and the size of the purifiers may be reduced correspondingly, large reductions in capital costs being thereby realized. Existing purifiers can be adapted to the cold-warm process and, if equipped with larger connections and valves, will be able to handle the additional gas produced as a result of an extension of the carbonizing plant, additional purifiers being then unnecessary.

[Reference to this process was made by Mr. J. E. Wakeford, of Brighouse, in his address to the Yorkshire Junior Gas Association reported in the "Journal" of Dec. 6 last, p. 716.—Ed. "G.J."]

Two C.O.L. Intermittent Vertical Chamber Plants

Operating Results

Results are now available of the operation of two C.O.L. intermittent vertical chamber installations—the plant at the Brentford Station of the Gas Light and Coke Company, and the Vancouver plant of the British Columbia Electric Power and Gas Company.

Both of these are first sections of larger installations, and, as it is hoped in due course to publish full particulars on the operation of the completed plants, the data given here merely summarize the operating records of each of the said first sections taken on lengthy test runs during normal working.

Brentford Plant of the Gas Light and Coke Company.

The C.O.L. installation at the Brentford Station of the Gas Light and Coke Company forms part of the very extensive reconstruction scheme being carried out there.

Shortly after the amalgamation of the Brentford Gas Company with the Gas Light and Coke Company, a large scheme of modernization was decided upon which is now nearing completion, the capacity of the station having been increased thereby from 5½ million to 16 million c.ft. per day. The work has had to be spread over a period of about six years owing to the difficult shape and restricted area of the site, while at the same time it was necessary to continue manufacture of gas in parts of the plant during the alterations.

The site consists of a narrow strip of land between the River Thames and the High Street, but since its position is definitely advantageous for receiving sea-borne coal at an economical rate, it was laid out to obtain the utmost capacity on the area available, and it followed that the choice lay between continuous vertical retorts and intermittent vertical chambers.

About the time the plant was under consideration, attention was being drawn to the claims of intermittent vertical chambers, which, as is now generally known, had been developed in Germany during the period when continuous verticals were making headway in this country.

At this time—*i.e.*, in 1927—there were only one or two installations of intermittent vertical chambers in this country, and, as Durham coal was to be used at Brentford, it was considered desirable to demonstrate their suitability on a large practical scale.

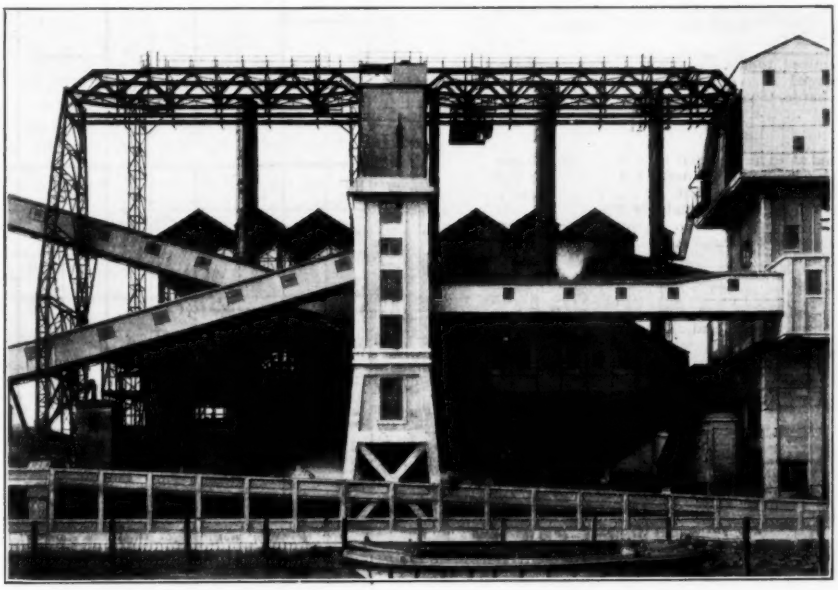
To this end, the Gas Light and Coke Company's Engineers collaborated with Chamber Ovens, Ltd., in a test on a plant of this kind at Bremerhaven in Germany, whither a special consignment of Londonderry coal was shipped and carbonized in the C.O.L. chambers at the gas-works of that town in the presence of the Gas Light and Coke Company's officials. The test was very successful from every point of view, the results actually exceeding expectations. These results were given in 1927 in a paper read by Mr. N. J. Bowater before the Institute of Fuel, and subsequently at the joint Gas Conference held in 1928 in Birmingham.

Tenders were then invited for a carbonizing plant, having a capacity of 5,000,000 c.ft. per day—the first half of the complete carbonizing installation. Intermittent vertical chambers were adopted and the contract was placed with Chamber Ovens, Ltd. (now incorporated in Gas Chambers and Coke Ovens, Ltd.). This was the first plant of vertical chambers to be installed by the Gas Light and Coke Company, although through unforeseen delays it was not the first (by a long time) to be put into operation.

Subsequently, in 1929, a further contract was placed with Gas Chambers and Coke Ovens, Ltd., for an extension to this plant, of equal size, making the total plant capacity 10,000,000 c.ft. of gas per day.

The first unit of 5,000,000 c.ft., which has now been in operation for nearly two years, consists of 48 chambers holding approximately 4·2 tons each, the carbonizing plant being complete with self-contained hot gas producers, and coal charging and coke quenching equipment.

The peculiarities of the site necessitated the plant being arranged in two benches, each of 24 chambers. Due to the nature of the ground along the river bank it was essential to build the plant on a reinforced concrete raft carried upon approximately 220 40-ft. pre-cast concrete piles.



GENERAL VIEW OF THE 10,000,000 C.FT. CHAMBER OVEN PLANT FOR THE GAS LIGHT AND COKE COMPANY AT BRENTFORD.

Each bench of 24 chambers is provided with its own storage bunker, capable of holding 48 hours' supply of coal, together with its own electrically driven coal charging and coke quenching cars. The former has separate compartments for coal and coke breeze, and is so designed that the movement of the car between the breeze and coal charging operations is unnecessary.

Each chamber is provided with three charging ports fitted with self-sealing lids for the charging of the coal and breeze, and, to minimize the emission of smoke during charging, telescopic sleeves are provided on the outlets of the coal charging car, these sleeves, which are electrically interlocked with the travel gear, being dropped on to the chamber charging hole frames during coal charging.

Both top and bottom gas offtakes are fitted to each chamber, the latter with the object of avoiding the accumulation of pressure at the bottom of the chambers with its consequent disadvantages.

The two benches of 24 chambers are built in four settings each, the two end settings having five chambers and two centre settings seven chambers, the five chamber settings having one and the seven chamber settings having, however, each two producers per setting, in order to keep down the size of the individual producer grates.

At or towards the end of carbonization, steaming is car-

ried on long enough to produce the necessary quantity of water gas to break down the straight gas to 500-520 B.Th.U.

The hot coke is then dropped into a skip carried on an electrically propelled chassis, which is traversed into a quenching chamber where the coke is quenched.

The first unit of plant was completed in 1929, but, owing to unavoidable delay in completing other essential parts of the works (due to difficulties arising from the restricted site) the plant was not heated up till 1931.

It has now been running for over two years, carbonizing individually (*i.e.*, not mixed or blended) a large variety of Durham run-of-mine coals, which covered a very wide range as regards gas-making quality, carbonizing temperature requirements, swelling properties, steam conversion efficiency, &c. The carefully collated records of the operation of the plant show throughout that changes of coal quality every two or three days do not conduce to the achievement of highest efficiencies as regards either thermal yield or fuel consumption.

This was especially clearly illustrated during a lengthy test run which was carried out over a period of six weeks' ordinary operation of the plant in February and March last, the results of the run being given below:

BRENTFORD No. 1.

RESULT FOR PERIOD 27/1/33 TO 10/3/33.

[Duration of Test—40 days.]

COAL—

Coals used	Townley	Londonderry	Horden
	Silksworth	Boldon	Ravensworth Pelaw
	Thornley	Holmside	New Pelton
	Easington	Hebburn Main	South Hetton
	Lambton	Pelaw Main	Ryhope
	Priestman's Gas Coal		

Weight of coal carbonized, tons	13,439
No. of chambers charged	3,246
Weight of coal per charge, tons	4·14
Inerts in coal, %	10·19

CHAMBER GAS—

Total made, saturated at 30 in., and 60° F., c.ft.	206,730,000
Yield per ton of coal, containing 8% inerts, c.ft.	15,740
Calorific value (gross), B.Th.U. per c.ft.	510·2
Thermal yield per ton of coal, containing 8% inerts, therms	80·3
Yield per chamber per day, therms	550·0

COKE—No facilities for weighing.

PRODUCER COKE—

Total dry coke to producers, tons	1960·42
Fuel consumption—dry coke/raw coal, %	14·59

OPERATING CONDITIONS—

Charging period	13 hours 36 mins.
Steaming ,,	4 ,, 5 ,,
Combustion flue temperatures—	
Top row	978° C.
4th ,,	1309° ,,
3rd ,,	1317° ,,
2nd ,,	1307° ,,
Bottom	1287° ,,

TABLE I.—*Coal Analysis.*

[Proximate analysis (as charged)—average.]

Moisture	3·59
Ash	6·60
Volatile	..
Fixed carbon	..

TABLE II.—*Gas Analysis.*

[Chamber Gas.]

CO_2	2·0
O_2	0·3
C_nH_m	2·7
CO	13·2
H_2	53·1
CH_4	21·1
N_2	7·6
	100·0

The average results obtained over the six weeks' period alongside the guarantees are given in the following table:

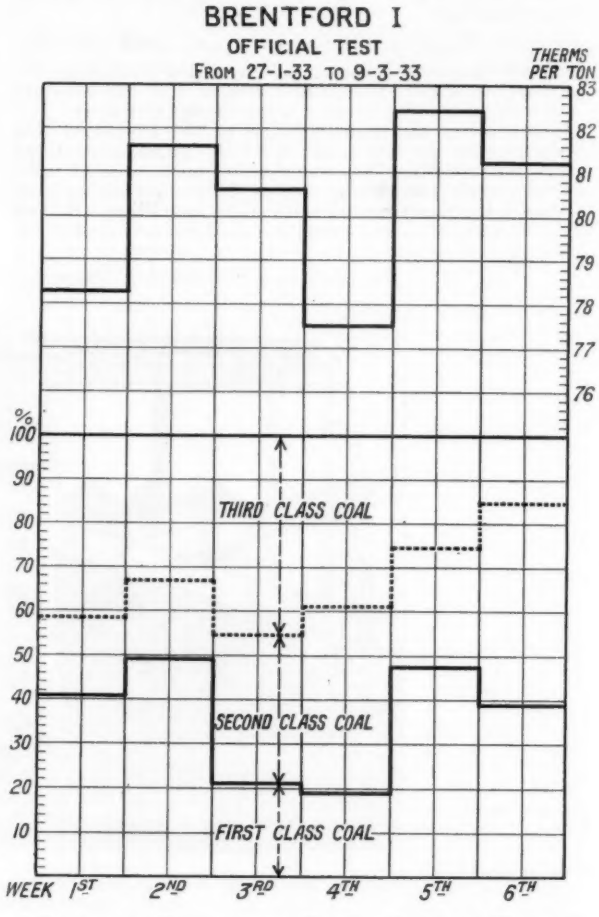
—	Guaranteed.	Achieved.
Throughput per day, tons	325	336
Gas make per ton of basic coal containing 8% inerts, c.ft.	15,680	15,740
Therms per ton of basic coal containing 8% inerts	80	80·3
Calorific value of gas, B.Th.U. per c.ft.	510	510·2
Fuel consumption, dry coke/raw coal, %	14·5	14·59

During the test 16 varieties of Durham coal were carbonized, varying from first-class to inferior second. Average samples thereof were taken during each succeeding week and analyzed, while the percentage of the various classes of coal supplied to the plant were ascertained and the weekly variation in the thermal yield per ton of basic coal containing 8% ash *plus* moisture established.

The effect of the frequent change of coals is graphically demonstrated in the two curves given. The gaseous therms yielded per ton of coal clearly follow the variation in coal qualities, the highest result being 82·4 therms per ton during the week when 48% of first-class coal was carbonized, while the lowest was 77·5 therms when only 20% was utilized.

This is an instance in which the blending or mixing of the coals would be of outstanding advantage for the establishing of optimum carbonizing conditions, but unfortunately there were no facilities for so doing at Brentford, restriction of site precluding the provision of the requisite equipment.

The second section of the plant, consisting of two benches of 24 chambers each, has now been installed, and will be heated up at an early date.



VANCOUVER PLANT OF THE BRITISH COLUMBIA ELECTRIC POWER AND GAS COMPANY.

The Vancouver plant was generally described in our issue of May 3, 1933.

The first section, to which the results below refer, consists of a battery of 24 C.O.L. intermittent vertical chambers, together with complete coal and coke handling plant. The chambers are fired with clean, cold producer gas supplied by two mechanical gas producers of the Lymn-Rambush type. Waste heat is utilized for steam raising to the fullest possible extent, the producers being water-jacketed and the hot producer gas passing through high-pressure waste-heat boilers before it is cooled and cleaned in Lymn washers. The waste heat in the combustion gases from the setting is also used for steam raising in a high-pressure waste-heat boiler of the Spencer Bonecourt type.

This section has now been at work for twelve months, and the results given below are those obtained during the month of May—a period of 31 days—in the normal working of the plant (and are being obtained regularly on the plant with the same moderate temperatures).

The coal used was mainly a blend of Vancouver Island coals, but a small quantity of Mainland coking coal was also separately carbonized with a view to producing good quality foundry coke. From the results, it will be seen that the expectations that local coals could be successfully utilized in the plant have been very satisfactorily realized.

It will be seen from the data given that the local coals are (by English standards) of poor quality with a high

GENERAL VIEW OF THE 3,000,000 C.FT. VERTICAL CHAMBER PLANT AT VANCOUVER WITH COAL HANDLING AND BLENDING PLANT FOR 6,000,000 C.FT.

ash and moisture content (11% and 6% respectively). Nevertheless the coke produced is much superior for Canadian domestic purposes to that made from the same coal in continuous vertical retorts, while from the Mainland coking coal an excellent foundry coke was made. The high ash content of the coke (from Vancouver Island coal), however, makes it a difficult fuel for use in self-contained gas producers. It emphasizes the value to the plant of the outside mechanical producers and was indeed an important reason for installing them. It is pleasing to record that they have entirely justified themselves.

VANCOUVER No. 1.

RESULTS FOR MAY, 1933.

[Duration of run—31 days.]

COAL—	
Blends used (1) 50% Comox, tons	4950·2
50% Western fuel, tons	
(2) Michel (Mainland), tons	52·2
Total weight of coal carbonized, tons	5002·4
Number of chambers charged	1230
Weight of coal per charge, tons	4·07
Inerts in coal, %	17·2
STEAM TO CHAMBERS—	
Total to chambers, tons	933·4
Percentage by weight of coal, %	18·7
OVEN GAS—	
Total made saturated at 30 in. and 60° F., c.ft.	100,530,000
Yield per ton of coal, c.ft.	20,096
Calorific value (gross), B.Th.U. per c.ft.	473·7
Thermal yield per ton of coal as received (17·2% inerts), therms	95·2
Yield per chamber per day, therms	665
COKE—	
Yield of dry coke per ton of dry coal carbonized, lbs.	1515

NOTE.—It was not possible to weigh all the coke made, and the figure of coke yield given is based on the results previously obtained by the Canadian Fuel Research Board on this plant, using the same blend of coals and under the same carbonizing and steaming conditions.

PRODUCER GAS—	
Total made saturated at 30 in. and 60° F., c.ft.	173,208,000
Calorific value (net) at N.T.P., B.Th.U. per c.ft.	135
STEAM RAISED—	
Steam raised from and at 212° F. in low-pressure producer boilers, lbs.	1,276,400
Steam raised from and at 212° F. in high-pressure producer boilers, lbs.	1,741,050
Steam raised from and at 212° F. in waste-heat boiler on chamber bench, lbs.	5,397,600
Total steam raised from and at 212° F. per ton of coal carbonized, lbs.	1,681
FUEL CONSUMPTION—	
Total gaseous therms to chamber bench, therms	217,030
Thermal equivalent of steam raised in chamber bench waste-heat boiler (efficiency, 80%), therms	65,473
Net gaseous therms for carbonizing proper, therms	151,557
Net gaseous therms per ton of coal carbonized, therms	30·3
OPERATING CONDITIONS—	
Charging period	14 hours
Steaming period	4½ ,,
Combustion flue temperatures—	
Top row	937° C.
5th row	1265° ,,
4th row	1281° ,,
3rd row	1282° ,,
2nd row	1279° ,,
Bottom row	1269° ,,

TABLE I.—*Coal Analysis.*

[Proximate analysis (as charged)]

Moisture	6·2%
Ash	11·0 ,,
Volatile matter	31·8 ,,
Fixed carbon	51·0 ,,
	100·0 ,,

TABLE II.—*Gas Analyses.*

—	Chamber Gas.	Producer Gas.
	%	%
CO_2	5·0	5·9
O_2	0·4	..
C_nH_m	2·3	..
CO	20·4	27·6
H_2	48·4	11·6
CH_4	13·6	0·7
N_2	9·9	54·2
	100·0	100·0
Calorific value (B.Th.U. per c.ft.) at 30 in. and 60° F. saturated.	473·7	135

In view of the high gaseous thermal yield obtained—viz., over 95 therms per ton of coal as delivered—the moderate temperatures used are worthy of note. As will be seen, the maximum temperature employed was only 1282° C.

The second section of the plant, consisting of an additional 12 C.O.L. chambers with the necessary gas-producing plant, is being installed, and it is hoped to publish full description and results when the extended plant has been in operation for some time.

In addition to the coals used in the test, a number of other coals have been carbonized in the plant in the presence of engineers from the Fuel Research Laboratories of the Canadian Department of Mines, and these tests are referred to in a paper read by Messrs. Haanel and Strong before the Canadian Gas Association at the Convention on Sept. 18, 1933. In this paper the authors state:

> "... exhaustive tests on the principal coking coals of British Columbia and two from the Province of Alberta were carried out in the new vertical chambers. All the coals were coked individually and as blends in varying proportions with Vancouver Island coals—steamed and without steaming—and the results offered a wide selection of coals and blends from which a suitable choice could be made."

The system of heating the C.O.L. chamber is worthy of mention in that there are multiple burner flues extending to approximately one-third the height of the chambers. These, together with a horizontal arrangement of the heating flues, enable good top temperatures to be obtained with moderate bottom temperatures, and thus permit achievement of the three desiderata—viz.:

1. High average wall temperatures.
2. Moderate maximum temperatures.
3. Moderate temperature gradient.

Australian Gas Institute

PRESIDENTIAL ADDRESS*

Of C. F. Broadhead, Engineer, Metropolitan Gas Company, Melbourne.

It is difficult on my part to discover cause for any remarkable display of enthusiasm regarding the position of the Gas Industry at the present time. It becomes increasingly evident to those able to read the signs of the times that this old-established public utility has very definitely arrived at the parting of the ways. The stage has been reached when it is necessary to dissociate stability from stagnation and effect radical changes in order to place ourselves in line with contemporary progress. If this is not done, a gradual recession into the background will take place—imperceptible at first, but inevitable nevertheless.

It is certain that potentially there is a greater domestic and industrial field for gas than ever before, but it is equally true that gas is by no means maintaining its position in the race for business against its more youthful and alert competitors.

The prosperity enjoyed by gas for such a long period has produced an inordinate amount of complacency resulting in almost complete failure in many quarters to estimate, or even recognize, the progress and strength of our competitors. But, in addition, there are avoidable contributing factors, large and small, in the manufacturing, distributing, and selling sections of the business. The manufacture of gas and production of residuals naturally constitute the chief thought of technical officers; so much so that it has been stated that with the types of gas-making plant available to-day the production either of gas or coke of suitable quality, under conditions of high thermal efficiency, has reached somewhere approaching its zenith; also that the future development of the Gas Industry will, therefore, have to be won by other means than the mere reduction of cost through perfected carbonizing arrangements. This may be true in its application to the extraction of a relatively small percentage of the total heat units of the coal in the form of gas. But does the Industry intend to rest content with a low production of therms in the form of gas, and to continue selling a larger volume of therms in the form of solid and liquid fuel?

More Gas—Less Coke.

It is high time, in view of the attention now being given to coke and coke oven practice in the home of the Gas Industry, to ask whether our main objective is really to produce and supply gas satisfactorily. It would appear that, generally speaking, unless heat units are of greater value in the form of gas than they are in the form of coke, our future prosperity is based on a somewhat insecure foundation. In the past, when gas had virtually a monopoly of the lighting and heating business, satisfactory progress was made with comparatively inefficient carbonizing practice, but present-day competition necessitates the delivery of a heating medium in a cheap, clean, and convenient form. This is only to be brought about by the conversion of a greater percentage of the coal into gaseous energy, and most decidedly in plant requiring considerably less capital outlay, repairs, and labour than is possible by the best-known existing methods. The matter of a general reduction in capital expenditure on plant per gas unit sold will require careful consideration by future gas administrators. The whole process of coal gas production to-day is unwieldy and could be reduced to a simpler and more compact operation. The principal direction in which this may be accomplished is a diminution in the amount of coal, and consequently residuals, to be handled.

The natural yield of inert-free gas per ton of the best Maitland coal is not more than 80 therms, which may be increased to 100 therms, or even more, of 500 B.Th.U. gas by steaming in suitably heated vertical retorts.

Consider, in the first place, the position in relation to very small works. Is it conceivable that in future the whole cost of operating a small undertaking profitably can be carried by a single setting of stop-end retorts working less than the full twenty-four hours per day and converting 30 to 40% of the heat units in the coal into gas, though consuming coke during the whole time? In my opinion it is not.

In many small towns in Australia coke and tar have been profitable bye-products, but their value is more likely to decrease than otherwise.

The use of high-quality Maitland coal has made it difficult for small works to produce gas of reasonable calorific value and composition. Various methods for regulating the addition of producer gas have effected an improvement in the direction of efficiency and economy, but the process still retains undesirable features and cannot be regarded as anything but an expedient. It is a little surprising that no Australian undertaking of suitable size has adopted the "Simplex" blue gas plant as an adjunct to its carbonizing equipment. Some marked advance in small works technique is long overdue.

Medium-sized undertakings, by which is meant those having an annual output of 100 to 500 million c.ft., equipped with vertical plant capable of a high thermal production from the coal carbonized, and having a good industrial market for coke, appear to me to be in a comparatively strong position.

For large undertakings horizontal and inclined retorts should be things of the past, and in spite of progress recently made by intermittent verticals, with their excellent therm production, low carbonizing costs, and smooth working, it is exceedingly doubtful if they could be considered, except in specially favourable coke demand districts, as rivalling continuous verticals for the carbonization of the rich Maitland coal generally in use in Australia. The fact that the capital cities of Australia rely almost entirely on the continuous process confirms this view. It has, however, been a matter of speculation to me as to why the top heating of continuous verticals has been so freely adopted. It has little or no advantage in the carbonization of Maitland coal, the effect on the gas and tar yield being negligible, but its effect in connection with damage to silica material in the hot zone has been positively disastrous. The higher temperatures employed in retorts with silica settings cause degradation of rich gas, with heavy loss through carbon production and consequent time off for scurfing. Further, a distinct loss of efficiency is evident when bottom heats are too low for the removal, by steaming, of the last traces of volatile matter in the coke and the gain of an amount of internal heating. It is not too much to claim that an increase of up to 5% in therm production may be obtained by steaming, at practically no extra cost. Nevertheless, it is our experience that, though there is some advantage to be gained by steaming in all cases, and to a much greater extent with Maitland coal where no water gas plant is available, yet steaming beyond a comparatively limited range is less efficient than the direct production of gas in a modern water gas plant.

The Best Gas-Making Plant.

Without question the most perfect type of gas-producing plant in existence at the moment is the automatic completely self-operating carburetted water gas plant. The capital and repair costs are relatively low, and labour charges are reduced to a minimum. By using coke the process has the great advantage of utilizing a bye-product of coal gas manufacture. In addition, it relies for enrichment on an oil residue resulting in probably the cheapest all-round therm at present, and, under existing conditions of world oil production, likely to remain so for some time. Experiments have shown also that water gas enrichment may be obtained from vertical retort tar at a lower cost than from oil, with the additional advantage of the production of a high-grade water gas tar as a residual.

If coke used in water gas manufacture be charged at the same price as the coal carbonized it will be found that water gas costs less per therm than gas produced in continuous vertical retorts. Further, it is impossible to estimate in pounds, shillings, and pence the collateral advantages of water gas plant in the direction of flexibility in covering a wide range of varying demand and the maintenance of an unvarying quality of gas.

Is it not logical to conclude that the greatest hope for the future is in a combination of water gas and vertical retort practice in a single plant, which would eventually result in the complete gasification of every ton of coal brought into the works? Apart from the saving in operating charges occasioned by the use of the combined plant instead of separate plants, this would result in a large reduction in capital outlay and repair charges, the elimination of coke-handling charges, and a further conservation of heat.

It would seem that we should endeavour to produce 75%

* Read at the Seventh Convention, held in Melbourne, on Nov. 14, 1933.

of water gas and 25% of coal gas, instead of the present ratio of approximately 75% coal gas and 25% water gas. No difficulty would be experienced in producing 50,000 c.ft. of 400 B.Th.U. gas (200 therms) per ton of Maitland coal. Progressive undertakings the world over have already moved in this direction by the adoption of water gas manufacture; and small Australian works, which will require to operate only one or, at the most, two shifts per diem, will eventually be able to supply, by means of complete gasification, a gas of greater service to their consumers at less cost than hitherto.

The carbon monoxide bogey, sure to be raised by the suggestion of increased water gas content, may be laid low by the simple statement that as a rule gas poisoning is not the result of direct inhalation of gas, but of incomplete combustion, the risk of the latter being less in the case of carbon monoxide than in that of higher calorific constituents.

In a recent and most interesting review of the Industry in Great Britain it is stated that the new attitude towards coke—the need for care in its production, cleaning, screening, &c.—which has grown up, should lead to greater appreciation of this smokeless fuel by the public. There may be some justification for the efforts referred to in the case of coke sold for metallurgical and industrial purposes, but if the propaganda is intended for the extension of its use for domestic heating of any kind, it may be pertinent to ask how long the Industry intends to speak with two voices on this matter. Possibly, sufficiently long enough to fall between two stools. Does a gas-works heat its retorts by the direct combustion of coke? Certainly not, but by gaseous heating. Are we not converting an increasing quantity of coke into gas in producers and water gas plant? Why then should we invite gas consumers to use coke in competition with our principal product and, in some cases, be so extremely stupid as to urge them to assist its combustion by means of a gas burner? The sale of coke should be gradually changed to the supply of gas for domestic purposes. The Metropolitan Gas Company has taken off the market over 150,000 tons of coke during the past three years. In the same period the Electricity Commission has placed on the market over 700,000 tons of briquettes at low and unprofitable prices. It is quite safe to predict that the State will, at some distant date, pay even more dearly than at present for this wholesale encouragement of the use of solid fuel. As a final point, if we are to be solid fuel merchants, why should not coke pay its proper proportion of processing cost in the carbonizing plant—not to mention the cost of handling, grading, and selling? In which case the sale of the bulk of our coke breeze at a low price to the Electricity Supply Department, for the generation of electrical energy, would assume a still more unfavourable aspect.

The Tar Market.

A remarkable change for the worse has overtaken the tar market in Australia during the past ten years. In 1922 the Metropolitan Gas Company sold for road-making purposes 4½ million gallons of tar, equal to a revenue of 6d. per 1000 c.ft. of gas sold. In 1932 the total production of tar was over 5 million gallons, of which less than 2½ million gallons were sold for road-making purposes, while the revenue dropped to 2·39d. per 1000 c.ft. sold. The cause of this fall in revenue was, without question, a combination of circumstances—the unsuitability of straight distilled vertical tar for modern road construction, and the dumping of unlimited quantities of an excellent road surfacing material in the form of bitumen at extraordinarily low prices. In an endeavour to meet the position a chemically treated tar was put on the market by my Company, which, it is safe to say, is definitely superior to any straight distilled horizontal or even coke oven tar ever produced. It may be mentioned, in passing, that the material now used in the process is refuse collected by the Bradford Corporation at their sewage works, and is recovered from the scouring of Australian wool; also that this material, in contradistinction to bitumen, is subjected to a heavy Customs Duty. It may be of interest to members and others to learn that over 10,000 tons of Bitural have been sold in Victoria, chiefly to the Country Roads Board, after subjection to rigorous tests with which no tar whatever, produced by ordinary distillation methods, could possibly comply. And this in spite of the fact that for the past two years bitumen has been sold in large quantities at about £6 10s. per ton, and, it may be remarked, with a complete absence of the usual hysterical howl for high protective tariffs raised in the case of other imported commodities.

We have now entered into active competition with the suppliers of bitumen in the direction of replacing their oil with tar for fuel purposes, and have recently made arrangements with certain woollen mills and hosiery manufacturers for supplies of tar to the extent of over 2,000,000 gallons per annum. The sales of tar for road-making purposes, principally primer coat tar and Bitural, will account for an equal amount, leaving the remaining quantity of approximately one million gallons to be turned into gas in the water gas plant—by far the most profitable outlet and an instance of the sound theory of complete gasification.

The production of sulphate of ammonia from gas manufacture is now mainly a method of disposing of ammoniacal liquor, and, on the whole, is unprofitable. Benzole recovery in Australia is a more problematical business proposition than in England, and one wonders if eventually it may not be overtaken by circumstances parallel to those now prevailing in connection with sulphate of ammonia production.

Gas "Conditioning."

The choice of condensing and washing plant depends to a large extent upon the size of the works. For comparatively small works the air-cooled condenser and standard types of washer will probably continue to find favour and function more or less satisfactorily. But for medium-sized and large undertakings the whole process of gas conditioning requires study from the angle of co-ordinating the various processes. In place of the old naphthalene bogey we have now to deal with compounds which polymerize and deposit resinous substances which gum up the valves and crack the leathers of meters.

Dr. Lenze, in his intense cooling process, has attempted, with considerable success, to remove in one operation all the water vapour, naphthalene, and ammonia, and so combine the processes of gas drying with those of washing and, in a degree, of purification. At the same time such unsaturated hydrocarbons as indene, styrene, and cumarone are condensed out. The removal of these compounds is extremely desirable on account of their gum-forming tendency. In this process weak liquor, which has been chilled by an ammonia absorption refrigerator, is sprayed into the gas, washes out the tar and naphthalene, and absorbs the ammonia. The tar and naphthalene are then separated out and the liquor is re-cooled and re-circulated, the excess—a very concentrated liquor—finding its way to the well. The gas is finally washed with a spray of chilled water to remove the last trace of ammonia.

A less ambitious scheme is being tried with some success at Washington University Experimental Station, where the gas is being cooled and scrubbed, in a Doherty washer-cooler, with its own condensate which has been chilled, whereby it is hoped to remove the tar, naphthalene, and ammonia without reducing the content of lighter hydrocarbons.

It will be apparent from the work and experiments quoted that the tendency is in the direction of improvement by means of condensing and washing with agents separately cooled or refrigerated so that the gas, entering comparatively warm, is cooled as it comes into contact with gradually cooler and purer solvent flowing in the opposite direction to meet it.

As part of the conditioning plant an electrical precipitator should be included, although from the point of view of its effect on the gas to be distributed it is not so necessary where a drying process is in use. On account of its efficiency and low power consumption the electrical precipitator is displacing all mechanical eliminators of tar-fog or dust, as it requires much less power and its performance is far superior. An additional advantage gained by its use is the certainty of securing clean sulphate of ammonia from direct recovery plant.

Sulphur Compounds Must Go.

The Gas Industry has, until comparatively recently, regarded "purification" as the complete removal from the gas of hydrogen sulphide only. There is danger in accepting this narrow and restricted definition of purification. The gas leaving the purifiers still contains substances which should be classed as impurities in the sense that they cause trouble in the distribution system and inconvenience to the consumer. Among such substances are hydrocyanic acid, carbon di-sulphide, resin-forming substances, oxygen, and water. The necessity for more effective purification must be recognized, and we should be satisfied with nothing less than a gas completely innocuous in its effect on mains, services, meters, and fittings.

Although various new methods have been tried for the removal of impurities, iron oxide is almost the sole purifying medium in general use. The outstanding advantage of oxide purification is its low cost, which the use of electrically driven disintegrators and mechanical handling has further reduced. The main disadvantages of the process are the large amount of ground space and plant required and the incomplete removal of impurities. In addition to heavy charges for emptying, refilling, and revivifying oxide, dry purification involves the disposal of

the spent material, for which there is a very poor market in this country. It is for these reasons that sodium carbonate washers have received so much attention. But even here a final oxide catch box is required to extract the last vestiges of sulphuretted hydrogen; this box must contain relatively unpolluted oxide, and to function properly must be of sufficiently large dimensions to permit the flow of gas. The result is that there is not very much saving of space.

It is possible, however, to obtain complete removal of hydrogen sulphide and hydrocyanic acid in a single operation. These impurities, together with moisture, can be removed from the gas at a cost only slightly higher than that for the removal of hydrogen sulphide only. This extra cost of producing a pure gas would certainly be far more than balanced by the consequent saving in distribution costs, and would result in an improved service.

Further consideration might well be given to liquid purification, and especially to the processes in which the sulphur is recovered, such as that developed by the Koppers Company, in which the solution remains perfectly clear throughout the entire cycle of purification and regeneration, and as a result the sulphur recovered is not contaminated by other solids. The solution possesses a low alkalinity consisting of soda ash partially neutralized by other constituents. The absorber removes the whole of the hydrocyanic acid and about 98% of the hydrogen sulphide, the remaining 2% being removed in two small oxide catch boxes. The entire plant occupies only one-third of the ground space that would be required by a dry purification plant. The process is carried out in two steps, absorption of hydrogen sulphide from the gas taking place in the absorber, and regeneration of the foul solution by aeration in the thionizer. The sulphur liberated in the second stage floats to the surface in a froth, overflows into a slurry tank, and passes to the sulphur filler.

Considering that more than one-half of the complaints of inadequate gas supply arise from the deposition of water or the corrosive effects of moisture in mains and services it will be recognized that the most important advance of recent years in the technique of gas manufacture is the practice of drying the gas before distribution. Of the three chief processes in use, compression, absorption, and refrigeration, the choice depends upon varying circumstances. If required for high-pressure long distance transmission, the gas may be washed very conveniently with cool water while compressed, and may also be more efficiently stripped of benzole, toluole, &c., by oil scrubbing while compressed. The subsequent expansion of the gas in passing through the pipes will keep it above the dew-point.

The absorption method, such as with calcium chloride, is simple and most suitable for installing in a works already fully equipped with washing and purifying apparatus. An opportunity will be provided for members to inspect a Holmes "Dri-Gas" plant at West Melbourne capable of dealing effectively with 15 million c.ft. of gas per diem.

The refrigeration process offers many attractive features not attainable by the other methods, such as the removal of undesirable constituents known to deteriorate meter leathers and to gum up the valve seats. Although the installation cost may be high the process cost should be comparatively inexpensive, as it is possible to employ an ammonia absorption-refrigerator utilizing low-pressure steam from waste-heat boilers or from the exhaust of steam engines.

If the experiment being carried out by Dr. Kemmer, of Berlin, to cool the gas by scrubbing it with chilled oil is successful in its practical application to the complete removal of benzole, toluole, and, above all, sulphuretted hydrogen and organic sulphur compounds, the Industry will witness the beginning of a new epoch in gas washing and purification—the complete co-ordination of the process of condensation, washing, purification, and desiccation. The process need not be unduly expensive, for heat exchangers will considerably reduce the power required for refrigeration.

Measuring Gas.

The correct registration of gas made on the works does not, as a rule, receive the close attention it deserves. This neglect is responsible, in a measure, for varying unaccounted-for gas figures. A number of factors contribute to the inaccuracy of the usual type of wet station meter—not the least being over-loading. The three large wet station meters at the West Melbourne Works have been replaced by two Connersville meters, each of a capacity of 8½ million c.ft. per diem. The cost of this tvpe of meter is much less than that of the old type, it occupies little ground space, is more accurate than the wet meter under everyday working conditions, and is essential as a part of the dry gas equipment.

The bulk of the gas storage capacity, even in fairly large undertakings, is almost invariably at the works. This has been a serious weakness in maintaining constant pressures, especially where no pressure raising plant and feeder mains are in existence. My Company is more fortunate in this regard, as only four of its thirteen gasholders are located at the manufacturing stations, and no holder has a greater capacity than 3 million c.ft.—probably the maximum size desirable for any undertaking adopting a decentralized storage system.

One disquieting feature in connection with gasholders has been the short life of steel sheeting used in recent times compared with the material supplied forty or fifty years ago. As a large-scale experiment we have erected holders with bells in mild steel, wrought iron, Armco, and copper-bearing steel. The latter material appears to be of outstanding merit, and, with the introduction of dry gas and the provision of an oil film on the tank water, should have a very extended life.

Apart from the delivery of dry gas at a constant pressure the waterless holder appears to have insufficient additional advantages to outweigh the risks inseparable from the absence of a positive seal, and the liability of the piston to get out of level with the consequent risk of dangerous air gas mixtures.

High-pressure storage has not been adopted in Melbourne because the cost of compression does not appear to be justified unless transmission over longer distances is contemplated.

An admirable storage medium would seem to be a spirally guided holder with copper-bearing steel sheets, in an annular tank containing a deep oil film.

In view of the placing in commission of the gas drying plant an oil spraying unit has been designed to prevent prospective rust blockages in the mains and services. With the same apparatus it is proposed to use also tetralin for the purpose of dissolving gummy deposits in meters. Tetralin is a hydrogenated product of naphthalene and offers further possibilities in the direction of an anti-corrosive film protecting mains and services internally.

A Construction Department.

At this point it may be convenient to mention the work done by the Metropolitan Company's Construction Department. The formation of this Department was an outcome of the war, as during that period it was difficult to obtain plant from overseas. Subsequent events have shown that the existence of such a Department, adequately equipped with machinery and plant, is an excellent insurance against delays from breakdowns, as working drawings, patterns, &c., are instantly available to enable repairs to be undertaken at a moment's notice. The extensive structural and fitting workshops at Fitzroy are now capable of completely fabricating a large gas-works from carbonizing plant to gasholders. A rigid contract entered into with a manufacturer to supply plant renders it somewhat difficult to make alterations during the currency of the work, and usually there would be no idea of varying the contract even though such variation would make for greater efficiency. With one's own Construction Department, however, there is greater flexibility, and every advantage is taken to simplify and improve plant as work proceeds upon it—such variations being considered in the light of future efficiency and reduction in cost. In the past far too much reliance has been placed on works contractors by gas administrators. A gas engineer should know precisely his plant requirements, and to be able to cater for them by his own staff and equipment is a great advantage.

Cast-Iron or Steel Mains.

It is not my desire to comment at any length on the relative merits of cast-iron and steel mains, but the occasion cannot be allowed to pass without reference to this important question. The Metropolitan Company has concentrated on cast-iron pipes for mainlaying, with the result that little trouble has been experienced with external corrosion or electrolysis.

It is not contended that cast-iron mains are immune from these ills, but the extra thickness of metal in the cast pipe, as compared with steel, assures a much longer life for the former, under equal conditions, with a consequent absence of anxiety.

The chief claims of the advocates of steel mains are, first, that a lower capital cost per mile is involved, and, secondly, by reason of the greater lengths available, fewer joints are necessary than is the case with cast-iron, thereby reducing the liability to leakage. This was good propaganda for the salesman, but to the practical mind the prime consideration is the effective life of the pipe. With steel, this is dependent altogether too much on the efficiency of the external wrapping, and, while every care may be taken to see that any defects discovered are carefully patched during the process of mainlaying, there is always the likeli-

hood of the covering on the underside of the pipes being damaged when driving the spigot home into the socket, and again later during the filling and ramming of the trench. This is particularly the case in stony country.

With the advent of the spun cast pipe, the claims of the steel people, with regard to both price and the number of joints per mile, to a large extent goes by the board. In the spun process, the weight of the pipe—compared with the vertically cast method—is reduced by approximately one-third; giving a corresponding increased mileage per ton, and, furthermore, pipes of 4 in. diameter and upwards are now manufactured in 16 ft. and 18 ft. lengths. The manufacture of spun pipes is a new industry in New South Wales, although the pipes cannot be purchased in Melbourne at present owing to an agreement with local manufacturers of cast-iron pipes amounting, one might consider, to a restraint of trade. Where semi-turned and bored joints are used, or effective couplings are employed, any anxiety as to leakage with a cast pipeline, working under high gas pressures, may be dismissed as of little consequence. My considered opinion is that we would be well advised to stick to the cast or spun pipe for reticulation purposes, for, after all, the cost of the installation is not a true gauge of the position.

The Metropolitan Board of Works has commenced the laying of fibrolite pipes with rubber joints. These are cheaper and, it is claimed, more lasting than cast-iron mains and will eliminate the electrolysis problem where they are installed. Tests which we have carried out, however, show that these pipes are not perfectly gas-tight, as under a pressure of 60 lbs. per sq. in. there is marked diffusion. Pipes made of this material by improved methods will be examined with interest. In any case the use of rubber joints on cast-iron mains might assist in the practical elimination of electrolytic corrosion. One feature of the fibrolite pipe which is causing some concern among electrical undertakings is that it has been customary for them to earth their protective devices on to water service pipes, the water main serving as a safe earth plate; with the use of non-conducting pipes, however, this will no longer be possible.

The problem of electrolytic corrosion of pipes and cables in Melbourne is exceptionally complex; for the city is traversed by tramway and railway systems, both operating on direct current from many sub-stations which are fed from different power sources, and, in addition, Melbourne possesses a soil of more than average conductivity. Consequently the preservation of steel mains and lead cable sheaths requires very careful study. The Electrolysis Committee in Melbourne, consisting of representatives of pipe and cable owning concerns and electric traction authorities, by superintending the more careful balance of loads between sub-stations and the installation of electrical drainage bonds, properly designed, has succeeded in greatly reducing the trouble, so that now the frequency of faults on the cables is less than one-third of its former value, and those on steel mains have been largely confined to a few definite areas where, it is hoped, they will be practically eliminated. Cast-iron mains have not suffered except in immediate proximity to steel mains to which they were connected. The unpopularity of drainage bonds in Europe is no doubt due to reports of the dire results following the haphazard use of them in America.

With regard to services, it has been decided, after full consideration, to lay underground only genuine puddled wrought-iron tubing and fittings, manufactured in accordance with the Specification drawn up by the Institution of Gas Engineers in Great Britain. The grade adopted is steam quality, and the tubes are coated externally, while hot, with a bituminous solution.

Consumers' Meters.

In connection with consumers' meters it is admitted that the wet meter is a positive measuring instrument, and therefore very accurate, providing certain precautions are exercised. It must be fixed dead level and care taken to maintain the correct water line. The capital cost of a wet meter is approximately 50% greater than that of the dry. Furthermore, in a warm country like Australia, the cost of watering meters amounts to approximately 1d. per 1000 c.ft. of gas sold. Finally, the nuisance of a wet meter on consumers' premises is not by any means a good selling point for gas. The dry meter has many advantages over the wet. It is much lighter and in consequence can be easily transported and handled. The dry meter takes up less space, particularly in the larger sizes, and with the advent of the high-capacity type this is most marked. Some years ago the position regarding defective dry meters caused us much concern. But the combined effects, over the last few years, of supplying a more efficiently washed and purified gas, low in inerts, together with a careful choice of materials used in dry meter construction, have resulted in a remarkable improvement in the non-registering returns, with a consequent reduction in the unaccounted-for gas figure to about 7%. Regarding the criticism often levelled at the dry meter that it is unreliable in registration, it may be mentioned that, on the average, meters tested after seven years' service are slightly slow, but within the limits of the Act. For the measurement of dry gas it is obvious that no other meter than a dry one should be considered.

The question of calorific values has latterly received an unusual and unnecessary amount of attention in Victoria. Though calorific values in Great Britain range between 200 and 560 B.Th.U., approximately 75% of the gas supplied is of 500 B.Th.U. It is my firm opinion that it would have been to the great advantage of the Gas Industry on the whole—to the suppliers, consumers, and appliance manufacturers—if the calorific value had been fixed definitely by law at 500 B.Th.U. Taking everything into consideration, including the incidence of distribution, there is no reason for higher calorific values than 500 B.Th.U. In the future complete gasification will provide an alternative standard, which value may be increased to 500, if desired, by oil or tar enrichment in the ordinary way or by the production of methane by catalysis, if such a process becomes a practical method of carburetting gas.

Appliance Governors.

Everyone is agreed that gas of a uniform quality is not only desirable, but essential. If we are to be consistent a uniform pressure at consumers' appliances is equally important. The only question is as to how this can best be done—whether by service governor fixed at the meter or by a governor fitted on each individual appliance. The preference should be for the latter, mainly from the point of view of elasticity. Where several appliances are installed in one building, each appliance governor may be set to a pre-determined pressure, the service line acting as a reservoir. This would enable district pressures to be increased, where necessary, making better use of the mains, services, and fittings, thus giving a satisfactory service to every appliance. The service governor, while of distinct advantage, does not wholly fill requirements when several appliances are in use at the same time. Another advantage of the governor as an integral part of the appliance is that it could be included in the selling price, whereas if the service governor were adopted the heavy cost involved would necessarily have to be borne by the gas undertaking. The saving to the consumer would in a very short time compensate for the additional cost of the appliance governor. The research laboratories at Watson House have evolved an excellent type of appliance governor which takes up little space, and these may be purchased by anyone requiring them. The Gas Light and Coke Company, it is understood, is making the whole of its patents available to the Gas Industry, and it may not be out of place to record the appreciation of this part of the world of this public spirited action.

Probably the most inspiring advance in the Gas Industry during the past decade has been in the design, appearance, and efficiency of gas consuming appliances. For this we have in a large measure to thank Radiation Ltd. The majority of the members of this Institute are considerably better informed than myself on the subject of appliances, but two outstanding improvements of great importance which should receive special commendation are thermostatic cooker control and non-condensate water heaters. There is every reason to anticipate further material improvements in the direction of domestic and industrial appliances. We know perfectly well that gas consumed in correctly regulated modern appliances gives relatively better value for money expended to-day than at any time previously. Where, then, is the weakness in the Gas Industry—for it is idle to deny that it exists? If one had to give an answer in a minimum of words it might be "In allowing things to go by default." In spite of examples of perfect street and interior lighting by gas we have lost almost the whole of our lighting load. And what has become of the gas engine? The internal combustion engine is one of the world's greatest achievements, and possibly no piece of mechanism has received more attention. But what have we done about it? The only thing appears to be a suggestion made that gas should replace petrol for propelling motor cars.

Nevertheless, while the number of gas engines in use has steadily declined until it has now almost reached vanishing point, it is encouraging to learn that the Gas Supply Company has recently connected in country districts no fewer than 22 engines of a total capacity of 565 h.p.—about half the horse-power, it should be stated, being for the generation of electricity at a cost for gas of 1d. per unit. The fact that this is in a town supplied with gas may give rise to some misgiving until it is explained that agreement exists as to the relative sphere of each commodity. As we shall most probably never regain the lighting and power

load at present prices, it becomes of paramount importance that we should hold our domestic consumption and intensively cultivate the industrial field.

Eventually gas and electricity will entirely replace solid and liquid fuels for the provision of heat and energy, and each has what may be termed its cost-convenience advantage. Lighting and motive power have almost entirely gone to electricity, while heat is still looked upon as exclusively the realm of gas—but, let us fully realize, by no means an undisputed right. A serious view must be taken of the electrical challenge in the direction of water heating and domestic cooking.

Although we advertise, with truth, the lower cost of gas compared with electricity for cooking and water heating, it should be remembered that, in contradistinction to increased prices for gas, the cost of electricity has decreased with its tremendously increased sale. Electrical progress will continue, checked to some extent possibly by the problem of peak loads. But if, as so confidently asserted, gas is the better and cheaper heating agent, why has electricity made such progress? Because it is the vogue, and being popularly looked upon as the future universal means of lighting, heating, and power it has received highly favoured treatment. But the outstanding reason is a vastly superior sales organization compared with that of the Gas Industry, and strong convenience points as the stock-in-trade of its salesmen.

On the relative merits of modern gas appliances, taking cost-convenience as the basis for comparison, the electric water heater or cooker should not exist. Further, it is totally unsound economically that additional capital should be invested in the electricity industry where gas plant capable of producing heat at less cost is lying idle. But the fault lies entirely with ourselves. Contrasted with the technical and secretarial sections, the sales side of the Gas Industry has been grossly neglected, and it can only be resuscitated in large undertakings by complete re-organization under the direction of a third executive who should be given the same freedom in the direction of his department as is now allowed present executive officers. The position of small undertakings in relation to sales organization is more difficult, but it is just as certain that radical reformation is necessary, and could be made to pay exceedingly well. The trouble appears to be in the dearth of suitably trained men.

An important factor militating against increased sales of gas in Australia has been the retention, until such a recent date, of the flat rate method of charging for gas. This situation has been due, to some extent, to legislative restrictions, but also, in a degree, to the lack of appreciation of the benefits to be obtained by adopting rates which are more equitable to consumers and likely at the same time to lead to greater consumption of gas. It is not within my province to attempt even the definition of a so-called scientific rate structure. But there are two or three major points to bear in mind when considering gas rates. In the first place the section of consumers that is definitely an unpayable proposition is a much larger percentage than is generally imagined. Secondly, that the fixing of specially low rates for gas used for any particular purpose may lead to inequitable treatment of consumers and consequent dissatisfaction, the purpose for which gas is consumed being no concern of the supplying undertaking. And, finally, if the rate structure is not framed in such a manner that it will eventually benefit all consumers, by the promotion of aggregate sales and consequently a general price reduction, it is unsound. There are numerous types of rate schedules, but, with variations, they may be divided into three main classes—the flat rate in which the price does not vary; the step rate under which a specified price is paid for the entire amount of gas consumed during a given period, the rate charged depending on the step in which the consumption falls; and the block rate under which a constant price is charged for gas consumed in the first block and lower prices for gas consumed in succeeding blocks. The step rate is naturally a great advance upon the old flat rate, but, in the June, 1933, American Gas Association Statistical Department's Bulletin on the trend of gas rate structures in the United States, it is stated that of the total general service or domestic rates the largest number were block rates. At the recent conference of Gas Executives in Australia it was considered that the minimum prices charged for gas in sliding-scales are not prices which are competitive with those of other industrial fuels, the grade not being sufficiently steep. It may be that the block rate provides the direction in which rate stability is to be found. In any case it will be imperative that the price of gas be reduced to the lowest possible point if we are successfully to withstand the onslaught of oil and electricity in the industrial field. No more significant example of oil-electric progress could be quoted than the advance of the combination Diesel-electric drive. The oil interests are ceaselessly active, their thermostatically controlled automatic installations being strong competitors in the hot water field, and our electrical rivals are resolute, resourceful, and energetic. It is useless to await the return of business to normal. The abnormal to-day is the normal of to-morrow. Much business lost during the depression will never be regained.

In all probability it will be felt by my fellow members that this address is of an unduly critical and somewhat pessimistic nature. And it might reasonably be suggested that the financial position of the Industry scarcely supports some of the views expressed. There is nothing illogical in the situation, however. The fact that such views are set forth under apparently favourable circumstances should call for more careful consideration than if the observations were the direct result of adverse conditions. Let us be under no illusion. We have finished with the easy going and prosperous past. And on the indications of the present, a period of intense progress and consequent re-adjustment of values, it is exceedingly doubtful, to my mind, if our existing standards will prove adequate for the future. The Gas Industry in its adherence to the dual production of solid and gaseous fuel is especially open to attack in the direction of revolutionary discoveries and improvements in the supply of modern heat and energy requirements. But you will agree that if we could by some magic means immediately commence to convert the whole of the available heat in coal into gas and deliver it at constant pressure to the latest gas appliances we should be in an almost impregnable position. We are not magicians, however, so instinctively turn from speculative to constructive contemplation.

In reviewing the position, therefore, an attempt has been made to embody a continuity of ideas for progressive development. The following information concerns the West Melbourne Plant as it existed twenty-nine years ago, as it is comprised at the present time, and as it could be twenty-five years hence, by which date complete supersession might warrantably take place. The three stages are:

Date.	Capacity Per Diem, Millions.	Type of Carbonizing Plant.	Area. Acres.	Acres per Million.
1904	5	Horizontal and inclined	17	3·40
1933	15	Continuous verticals and carburetted water gas plant	19	1·26
1958	30	Complete gasification and complete purification	12	0·40

The effect of complete purification would be the practical elimination of the whole of our distribution difficulties.

The ground area required per million c.ft. produced, together with capital and labour costs, would be drastically reduced.

Efficiency in the manufacture and supply of gas is the root and branch of good service, and no amount of sales talk or propaganda will offset variations in quality and pressure.

To raise our standard of efficiency to a height that would enable us to face the future with confidence we should, within the period covered by its obsolescence term, replace our manufacturing and purifying plant with modern equipment designed to produce one form of heat only—gas—entirely free from corrosive properties before and after combustion, so reinforce our distributing system that an adequate head of pressure exists at all times at the appliance, and elevate the sales department to a status in keeping with its importance.

In the Industry there exists, fortunately, an untapped reserve of strength accumulated from long experience, which, allied to the adoption of a clearly defined line of action in the direction of courageous and complete modernization of our methods, would dispel any doubt whatever as to the continued prosperity of gas.

Industrial Applications of Gas.

A survey of some of the many industrial applications of gas was made in a recent special Factory Re-Equipment Number of *The Times* Trade and Engineering Supplement, when particular emphasis was laid upon the advantages of thermostatic control. Such control renders gas ideal for the continuity of the process of mass-production, where delicate temperature adjustment is necessary over protracted periods.

Among the industries included in the survey, where gas plays an important and growing part, were the motor industry, the leather industry, the preparation of food, banana ripening, heat-treatment of high-speed steel, and the melting of non-ferrous metals, and the tobacco industry. The examples selected served to show the important part which the Gas Industry can play in the industrial re-equipment of the country.

Some Factors Involved in the Mechanical Testing of Bituminous Mixtures*

By W. G. Adam, B.A., F.I.C., M.I.Chem.E., and D. G. Murdoch, B.Sc., A.I C., A.M.I.Mech.E.

The work carried out in the recently equipped Technical Laboratory for the Mechanical Testing of Road Materials at the Products Works of the Gas Light and Coke Company has included a general investigation of the technique both of preparing test specimens from mixtures of mineral aggregate and a bituminous binder (viscous coal tar, soft pitch, and asphaltic bitumen), and also of certain tests which could be applied to such mixtures. The aim has been to determine the conditions necessary to obtain consistent results, with a view to their subsequent interpretation from the strictly practical point of view of road service.

It was recognized at the outset that the merits of any test would have to be considered in relation to the class of material under investigation, and that several tests would be necessary to provide sufficient data to indicate the future excellence or otherwise of a material to be subjected to the whole range of traffic and weather conditions.

In the investigation of the mechanical properties of any material, those tests which combine simplicity and speed with the required degree of accuracy are of special value, and when any such test is applicable to a wide range of materials, it is worthy of the closest possible study. For example, the tensile and compressive strengths of solid materials have long been measured, and the testing machines and apparatus have been brought to a high standard of perfection; these properties can be readily measured for a large number of materials used in road construction, and the possibility of their useful interpretation should, therefore, be a matter for careful consideration.

When it is desired to carry out any mechanical test, the following factors have to be considered:

A. Shape and size of test specimen.
B. Method of preparing test specimens in the laboratory.
C. Conditions of the actual test.

A. Shape and Size of Test Specimen.

Test specimens are at present generally prepared as cylinders, cubes, or rectangular slabs, or of figure 8 shape for the tensile test. When sufficient comparative data are available, it will be possible to determine which shape yields the most consistent results with a particular test. The question of shape is probably of greatest importance in the tensile test; the small tensile specimens used in the Beckton laboratory are prepared in moulds identical with those used by Dr. Herrmann at the Berlin Municipal Laboratory, Charlottenburg (see fig. 2), and have a more pronounced "waist" than the cement briquette prepared according to the British Standard Specification. The larger tensile specimens used are of the same shape as the standard cement briquette, but have three times the linear dimensions. Such specimens are in use at the Road Research Laboratory, Harmondsworth. It may here be mentioned that as far as possible the work at Beckton has been carried out with such apparatus and specimens as would allow results to be compared with those obtained at these two well-established laboratories.

The size of specimen to be used for each test is of first importance, and is governed primarily by the nature of the test. Apart from this it may be taken that, in general, the larger the specimen the better, and that the size must be considered in relation to the size of the largest aggregate in the mixture. It has been suggested, for example, that the smallest dimension of the specimen should be not less than five times that of the largest aggregate in the mixture, but a vast amount of experimental work will be required before a definite ratio can be fixed. For a wide range of asphaltic materials and fine tar concrete, tests which have now been in use for some time can be carried out on comparatively small specimens, and the results obtained are consistent among themselves and give information capable of being applied to the control of production. It will readily be understood that the question of size is of great consequence in so far as materials which require considerable pressure for compaction are concerned, large specimens of such materials demanding compression machinery of high capacity. Work carried out in the Beckton laboratory and referred to later in this paper has, however, indicated a possible means of obviating this (see "Methods of Compaction" (4)). Laboratory mechanical tests have also to be carried out on specimens taken from actual roads. For this purpose, slabs of material must be removed from the road and conveyed to the laboratory with the minimum of damage, and there cut to the required size and shape by means of a carborundum disc saw. It is also possible to cut cylinders of material from the road by means of specially designed portable core cutting machines. By either method the size and shape of specimen it is possible to cut without damage to the structure has yet to be determined for a large number of materials.

B. Method of Preparing Test Specimens in the Laboratory.

The method adopted for the preparation of test specimens must within certain limits be governed by the method used in actual road practice for the particular material, and consists of two stages:

(i.) Preparation of the material.
(ii.) Compaction of the prepared material.

(i.) *Preparation of the Material.*

With the exception of natural rock asphalt, which in its powdered state may be applied to the road without any addition, the materials under consideration consist of mineral aggregate and a binder which must be brought together and adequately mixed.

For laboratory investigations, such mixtures may either be withdrawn from a large-scale plant and conveyed to the laboratory as rapidly as possible in a closed and preferably heat insulated container, or may be prepared on a small scale in the laboratory itself, and in the latter case the closest attention to details is required.

Experience has been gained in the Beckton laboratory in the preparation of tar concrete mixtures consisting of closely graded aggregate [" coarse " (maximum size of aggregate $\frac{1}{2}$ in.-$\frac{3}{4}$ in.), and " fine " (maximum size of aggregate $\frac{1}{4}$ in.)] coated with a soft coal tar pitch. Mixtures are prepared by hand, careful attention being paid to the temperature and duration of mixing, both factors, as might be anticipated, having an effect on the results obtained on testing the compacted specimen. Sufficient of the mixture is prepared for one specimen only, the whole mix being placed in the mould; the amount necessary to give a specimen of the required depth in the direction of compression is found by trial. When, however, the size of the test specimen is extremely large in relation to the size of the largest particles of aggregate, it is obviously unnecessary to make separate mixtures of each mould.

If mechanical mixing is employed, it is necessary to ascertain in what respects, if any, the material obtained differs from that normally produced in the large-scale plant. An estimate of any crushing of aggregate that may have taken place in a mixer can be obtained by sieve analysis after removal of the binder with a suitable solvent in a centrifugal machine or continuous extraction apparatus.

(ii.) *Compaction of the Prepared Material.*

The prepared material at the correct temperature must be transferred to a mould for compaction by one of several available methods.

The moulds themselves, of which there are numerous patterns, are usually constructed of steel, and it is preferable that the inside and the plunger be very slightly greased. Although we have found that with some hot bituminous mixtures the temperature of the mould does not influence the density of the compacted specimen, it is probably generally desirable to use hot or warm moulds for those materials normally applied to the road in a heated condition; it has, in fact, been definitely claimed by other workers that the use of electrically heated moulds, the temperature of which can be maintained at a constant value during compaction, has given more uniform results than with moulds merely heated before use.

The method of compaction employed is of very considerable importance, and any comparison of such methods should have reference to certain important factors, viz.:

(*a*) Density of specimen obtained.
(*b*) Variation in density throughout the specimen.
(*c*) Crushing of aggregate taking place during compaction.

It is also necessary to know how these properties in a laboratory produced test specimen compare with those in specimens removed at intervals from actual roads constructed with the various materials.

Generally speaking, the problem is to obtain a specimen of a uniform density of the same order as that obtained in practice, and with no greater crushing of aggregate.

* From a paper before the Public Works, Roads, and Transport Congress, 1933.

The following methods of compaction will now be considered:

1. Tamping.
2. Ramming.
3. Compaction under gradually applied load.
4. Compaction by roller action.

1. *Tamping.*—This method consists in feeding the mixture at the appropriate temperature into the mould in portions, and compacting after each addition by means of a hand—or mechanically—operated tamper. One example of the method is contained in the recent description given by Hubbard and Field (Proc. Assn. Asphalt Paving Technologists, 1932) of their adaptation of the stability test for mixtures containing coarse aggregate. The tamper described by Emmons and Anderton (Proc. Am. Soc. Testing Materials, Pt. II., 1925) consists of an electro-magnetically operated hammer fitted with a square ended tamper, and strikes about 1500 blows per minute. The mould is gradually filled and compacted after each addition, and the contents finally levelled with a hot iron. It is claimed that this method gives high density specimens without fracturing the aggregate, and it is reasonable to assume that the density will be fairly uniform throughout. The use of a small area tamper permits a certain amount of kneading action, and will be referred to again later in connection with other methods of compaction. This method is certainly worthy of further investigation with a wide range of materials.

2. *Ramming.*—This was the first method used in the Beckton laboratory for the compaction of hot tar concrete mixtures, and consists in transferring the whole of the prepared mixture to the mould as evenly as possible with the aid of a steel spatula, placing the plunger in position, and allowing a ram to drop vertically on the latter a given number of times from a specified height. This method has received considerable attention in Germany, being embodied in D.I.N. specification 1995 (1929). A 12 Kg. ram is allowed to fall from a height of 25 cm. ten or twenty times according to the type of material being compacted.

3. *Comparison Under Gradually Applied Load.*—The prepared mixture is transferred to the mould evenly with a steel spatula. This even distribution is essential to obtain uniform compaction. The plunger is placed in position, and the mould transferred to the bottom platen of a compression machine; pressure is then gradually applied until the desired load has been reached, and this maximum load may be maintained for any given period. It is important that the time taken for compaction be noted and adhered to when repeat tests are carried out. When working with mixtures of closely graded aggregate and binder, if the rate at which the plunger is forced into the mould is fixed, then the rate of increase of pressure will depend upon the percentage binder in the mixture; the greater the percentage binder, the more rapidly will the maximum compaction pressure be reached. The plungers used are, in general, of the same area as the mould opening less a very small clearance, and the method is simple. The main factor to be determined for each material is the maximum compaction pressure, and on this there is as yet no general agreement.

It has been claimed, although not universally accepted, that mechanical tests on bituminous road mixtures are not capable of useful interpretation from the point of view of predicting behaviour in actual practice unless carried out on test specimens of bulk density equal to that obtained on the road after a period of, say, one or two years under traffic. The densities of specimens of materials removed from roads can readily be determined, and when a particular mixture is compacted in the laboratory the pressure can be increased until the corresponding density has been attained, assuming that compression machinery of sufficiently great capacity is available. Taking the extreme case, it has been found necessary with rock asphalt to use pressures of the order of 10,000 lbs. per sq. in., to obtain the required compaction density, and to prepare a slab specimen of, say, 1 sq. ft. face in the laboratory for a wheel indentation test, for example, a compression machine of over 600 tons capacity would be required—a considerable item in the equipment of a testing laboratory. Even if the same bulk density is obtained, it does not necessarily follow that the laboratory specimen is similar in all respects to the road specimen.

The material delivered to the road has been spread to the correct contour and then consolidated either by hand rammers and ironed (compressed asphalt), or by rolling (steam rolled asphalt, tar concrete, tar macadam), or has been spread by means of wooden floats (mastic asphalt). Whatever the type of material, further consolidation—small in the case of mastics, which contain a high percentage of binder, but to a greater extent with other materials—takes place under the influence of the wheels of vehicular traffic.

Consolidation by steam roller or by traffic is characterized by a kneading action, under which the particles in the mixture are enabled to re-arrange themselves in dense formation far more readily than under a steady load applied only in a vertical direction. As already indicated, it has been found that the equivalent compaction of mixtures in the laboratory by the gradually applied load method requires very high pressures, and it appears likely that with some materials far more crushing of aggregate takes place in the process than results from roller and traffic compaction.

The question of density variation in laboratory produced test specimens has been investigated by cutting up the specimens into sections and determining the density of the pieces. With all the mixtures investigated so far, the density is, as might be anticipated, greatest at the top, both with the ramming and steady pressure methods of compaction, although the variation with the latter method is less. The amount of crushing produced by these methods in the production of specimens of equal bulk density appears to be the same with the aggregate so far utilized.

The behaviour of bituminous mixtures under pressure in the confined space of a mould is dependent upon a number of factors, among which the following may be noted:

1. Properties of the aggregate (shape, hardness, and nature of surface).
2. Size of aggregate in relation to size of mould.
3. Shape of mould.
4. Grading of aggregate.
5. Physical properties of binder at the temperature of compaction.
6. Aggregate: binder ratio (thickness of film).
7. Voids in mixture at various degrees of compaction.

The difference in the distribution of applied pressure in compacting a cold bituminous macadam and a hot mastic—the behaviour of which approximates more to that of a viscous fluid rather than to that of a solid—is quite apparent in practice, and is a clear indication that the question of density variation in specimens compacted by various methods must be studied for each material.

It may also be said that the determination of variation in density and alteration in grading of aggregate by crushing in specimens of all classes of material cut from the actual road at intervals throughout its life constitutes an urgent task in this connection.

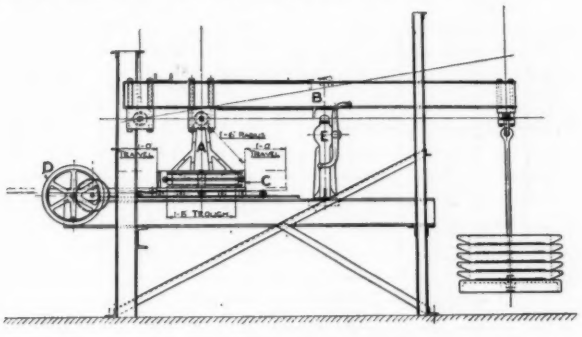
Many attempts have been made to overcome this difficulty of density variation and obtain a uniformly compacted specimen. With mixtures containing fine aggregate only, Hubbard has adopted a 1 in. high specimen in preference to a 2 in., and has obtained more even compaction. It has been proposed to use a plunger of one-third the area of the top surface of the specimen, gradually applying a load, releasing, and then moving the plunger to another position overlapping the first, and again applying pressure. The process is repeated until the whole surface has been subjected to pressure, and a final compression is given with a full area plunger. It is claimed that this method produces a compaction by kneading action—*i.e.*, a compression immediately underneath the plunger and a flow in the adjacent material.

4. *Compaction by Roller Action.*—Recognition of the essential differences between compaction by direct pressure and by the action of steam roller and traffic led to the installation of a roller compression machine in the Beckton laboratory, and the work so far carried out has indicated that it is likely to be a valuable method of preparing test specimens.

The machine was constructed to our requirements by Messrs. Saml. Denison & Son, Ltd., Leeds, and, as shown in fig. 1, consists of a wheel sector (A) mounted in roller bearings on a lever (B) pivoted at one end in roller bearings and carrying a scale pan at the other. With a leverage of 6 to 1, the load on the wheel sector roller may be varied between 30 cwt. and 6 tons by the addition of dead weights to the scale pan.

The mould (C) for containing the material to be compacted is 20 in. long by 9 in. wide by 5 in. deep, and consists of two angle walls and a baseplate, all of which are bolted together for use. Between the baseplate and bed of the machine is sandwiched a roller carriage, and the mould may be reciprocated under the wheel sector roller by means of a hand wheel (D) through a train of spur gearing operating a rack which is pin-jointed to the base plate. The free end of the beam has a considerable vertical freedom of travel, and a pointer attached at this end permits the distance of the roller from the bottom of the mould to be observed on a curved scale. To permit the necessary manipulation of the mould, a screw jack (E) is provided to raise the beam. The roller used in our experiments up to the present has been a sector of a 3 ft. diameter wheel and the same width as the inside of the mould less a clearance, but this can be replaced by one of different dimensions.

The method of operation is very simple, and consists merely in placing the material to be compacted in the slightly greased mould as evenly as possible, and then lowering the beam until the roller—also slightly greased—makes contact in the mould. Rolling is now commenced by reciprocating the mould with the hand wheel; if a load greater than the minimum of 30 cwt. is required on the roller the requisite weights are added gradually to the scale pan, the mould being kept in motion. Rolling is continued until the desired degree of compaction is obtained with the particular load, and the lever then raised by means of the jack, so that the specimen may be removed.



ROLLER COMPRESSION MACHINE FOR ROAD MATERIALS.

Fig. 1.

The mould is previously warmed when hot material is to be compacted, but is used at the laboratory temperature with ordinary cold bituminous macadam. In the latter case a thin wood lining is placed into the mould before use, to permit the removal of the compacted material without collapse.

Experiments carried out with tar concrete have shown:

(1) That specimen blocks can be obtained with a wheel sector load of, for example, 30 cwt. equal in density to those obtained by the gradually applied load method using a maximum pressure of 1 ton per sq. in. (equivalent to a total pressure of 180 tons on a specimen 20 in. by 9 in.).

(2) That the density of the roller compressed blocks is more uniform.

(3) That less crushing of aggregate takes place.

If work which it is hoped to carry out indicates that these results are equally true for a wide range of bituminous materials, then this method of compaction will certainly have very important claims for the consideration of those engaged in similar work and desiring to prepare large test specimens without the use of high-capacity compression machines.

In concluding this brief survey of the methods of preparation of test specimens, it should be mentioned that care is required in the removal of the compacted material from the mould, in order to avoid damage, even if it has been allowed to cool to the laboratory temperature, or below, in the mould. With split moulds the specimen can usually be removed by hand with comparative ease, but with single-piece moulds it is necessary to extrude the specimen slowly by means of pressure applied to a plunger.

Sufficient has been said to indicate that the question is one which must occupy considerable attention if the mechanical testing of bituminous materials is to be put on a sound basis.

C. Conditions of the Actual Tests.

1. *Temperature of Specimen.*—The compacted specimen must be allowed to attain the temperature at which the test is to be carried out, over a period of time, and under conditions which call for some investigation.

The time taken for a specimen of any particular size and shape to attain a given temperature throughout its mass may be determined by preparing a duplicate in which narrow cavities extending to various points have been formed either during the moulding of the specimen or by subsequent drilling in the compacted specimen. Into these cavities thermometers may be embedded, and the rate of change of temperature observed. Although a minimum time which must elapse before carrying out the test can be determined in this way, it appears likely that with some types of material mechanical tests carried out at intervals after this minimum time will continue to show variation for a period, and ultimately attain a value sufficiently constant for all practical purposes. The possibility of the existence of this stabilization period requires to be investigated for all bituminous mixtures.

The question of the temperatures at which the specimens are to be tested is dependent to some extent on the nature of the test, but it is evident that the whole range of road temperatures should at least be covered jointly by the group of different tests adopted as the most informative for the particular material. Tests at temperatures between $-10°$ C. and $+50°$ C. should provide all the necessary information.

The maintenance of the specimen at a constant temperature before the test is readily ensured if a refrigerator and an oven under thermostatic control are both available, but the method of ensuring constancy during the actual test must necessarily vary with the nature of the test. If it can be shown that no change in properties occurs when the compacted material is immersed in water, then the use of a thermostatically controlled water bath, containing a strong supporting platform, is suitable and convenient for those tests involving the application of a load to the surface of the specimen—compression, stability, and indentation tests, for example. Where the immersion of the specimen in water is undesirable, or at temperatures below zero, or again, for tensile tests with a vertically supported specimen, the matter is by no means so simple, and some form of air jacket should be used when temperatures outside the range of that possible to maintain in the laboratory are necessary. In this connection the duration of the actual test is a point to be considered when designing apparatus for heat insulation.

2. *Method of Applying Load to Specimens.*—Bituminous mixtures fall into the category of plastic materials, which are characterized by the property of flowing to a great or small degree under an applied load and of remaining permanently deformed; and in this respect they differ from rigid bodies—such as steel—which rapidly reach an equilibrium under load at ordinary temperatures, no further movement taking place, and are capable of recovering their original shape. For this reason the method of applying a load, whether tensile or compressive, is of first importance in the testing of plastic materials.

The following methods of testing under dead load are available:

(1) A load may be applied and maintained at a constant value. The resulting deformation will be instantaneous for rigid bodies and may be observed at any time, but with plastic bodies it will increase with time and must therefore be observed after a definite interval. This method of loading is used in certain deformation and indentation tests that are meeting with success in the testing of bituminous mixtures as providing an indication of the distortion likely to be caused at various temperatures by a heavy vehicle standing on the road.

(2) The applied load may be increased at a definite rate and the deformation observed at regular intervals and subsequently plotted in graphical form (or may be automatically recorded by a stress-strain recorder); if fracture or collapse occurs, the maximum load is noted.

The well-known standard apparatus (Frühling—Michaelis) for testing cement briquettes in tension is arranged to operate on this principle, the gradually increasing load being applied by lead shot pouring into a canister suspended on the beam. Water from a constant level tank flowing into a receptacle at the end of the beam of such a machine can similarly be utilized for the gradual increase of the load by regular and adjustable amounts.

On large single-lever testing machines, the load may be regularly increased by moving the poise weight along the beam at a steady rate, and balance maintained by adjusting the rate of strain as required, both operations being carried out by controlling the pressure from separate variable displacement oil pumps.

(3) The specimen may be subjected to strain at a definite rate (*i.e.*, controlled rate of deformation) and the load continuously increased as necessary to maintain the system in equilibrium. Here again the stress-strain data are observed at frequent intervals or automatically recorded. This principle is very commonly used for the routine testing of a wide range of materials. With the Denison Universal machine used in the Beckton laboratory it is possible to vary the rate of straining between the limits 0·05-2·4 in. per minute.

These three methods of applying a dead load have each been applied to the testing of bituminous mixtures. When any particular test involving the application of a variable load has become generally accepted as giving informative results of proved worth, it will obviously be necessary for the rate (or rates) of straining or loading to be standardized and rigidly adhered to by those desiring to obtain comparative results.

It may also be recognized that it is possible to apply a compressive load to a specimen either in, or perpendicular to, the direction of compaction. Quite apart from the obvious considerations of surface irregularity or lack of parallelism between the top and bottom faces, the factor is one which needs investigation.

Impact Testing.—Information may also be obtained by subjecting bituminous mixtures to loads applied suddenly—*i.e.*, impact testing. There are several ways in which this may be done, and the work so far carried out appears to have been mainly with the Page repeated impact machine, which was originally devised for testing the toughness of road aggregates, and has since been adapted for testing bituminous mixtures. A 4·4 lb. hammer is allowed to fall upon a plunger having a spherical end in contact with the specimen and supported in a vertical guide; the hammer falls 0·4 in. for the first blow, and this height is increased by 0·4 in. for each succeeding blow until the specimen fails. Modifications, chiefly in respect of the weight of the hammer, height of fall, and shape and dimensions of the end of the plunger have been proposed; the merits of these await the support of experimental results.

The influence of some of the factors which have been discussed is under investigation in the Beckton laboratory, and this work has been combined with a determination of the sensitiveness of certain tests to variation in the percentage binder in mixtures of graded granite and soft pitch. The following is a brief account of three of these tests, and the results are quoted as being an indication of widely differing response (under the specified conditions) to change in composition.

The hot mixtures were compacted by a gradually applied load of 3000 lbs. per sq. in. in a hydraulic compression machine, and conditioned in air for 48 hours before testing at 20° C.

1. *Tensile Test.*—The shape and size of the specimen are shown in fig. 2 (half actual size).

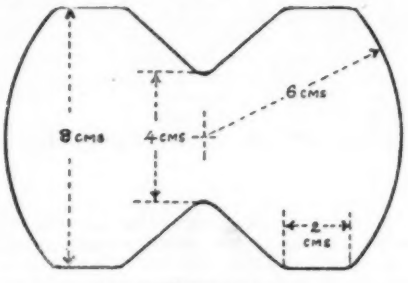


Fig. 2.—Thickness: 4 cm.

Rate of straining: 0·18 in. per minute.

The breaking stress only has been plotted in curve I.; this figure does not, of course, represent the total information obtainable from a tensile test.

2. *Compression Test.*—Shape and size of specimen: Cube, of 50 sq. cm. face area.

Rate of straining: 0·13 in. per minute.

Direction of compression at right angles to direction of compaction. The maximum stress is plotted in Curve II.

3. Sand-Blast Attrition Test.—The apparatus installed in the Beckton laboratory is of the Gutmann-Ottensen type.

Up to the present a blast pressure of 45 lbs. per sq. in. operating for 2 minutes has been employed. The speed of rotation of the specimen is approximately 30 r.p.m. about its own axis, and 20 r.p.m. about the axis of the machine. Each test utilizes about 3 lbs. sand.

The specimen is weighed before and after test, and the loss in weight converted to loss in volume for record purposes.

It is important to note that the exposed face of the specimen is appreciably warmed during blasting; the extent of this has not yet been accurately determined for the various bituminous mixtures.

The volume lost by various materials under standard test conditions is given in the following table for comparison:

—	Volume Loss (Cubic Centimetres).	1/Vol. Loss (For Comparison with Curve III.).
Yellow stock brick	50·6	0·02
Wire-cut stock brick	35·9	0·028
Oak { With grain	2·4	0·417
Oak { Across grain	4·1	0·244
Elm { With grain	3·1	0·323
Elm { Across grain	2·0	0·5
Lead	0·2	5·0
Ebonite	0·08	12·5
Rubber (red sheet)	0·01	100·0

The test period of two minutes cannot be claimed to be equivalent to any particular duration of traffic of given intensity; it is probable that abrasion rather than attrition is responsible for the greater part of the loss of material from a bituminous road surface. The test is, however, capable of giving rather more information than was at first anticipated; excess or deficiency of binder, over-heating of the mixture and faulty grading of aggregate, for example, affect the volume of material removed by the blast, and the test specimen provides a "relief" picture which should help an experienced road constructor.

The results of these three tests, Tensile, Compression, and Sand-Blast attrition are shown graphically in Curves I.-III.

Points to be noted are:

1. The different shapes of the curves, indicating different sensitiveness to the change in composition.
2. The different points at which maximum resistance is shown.
3. The halt in the rate of increase of resistance to attrition.

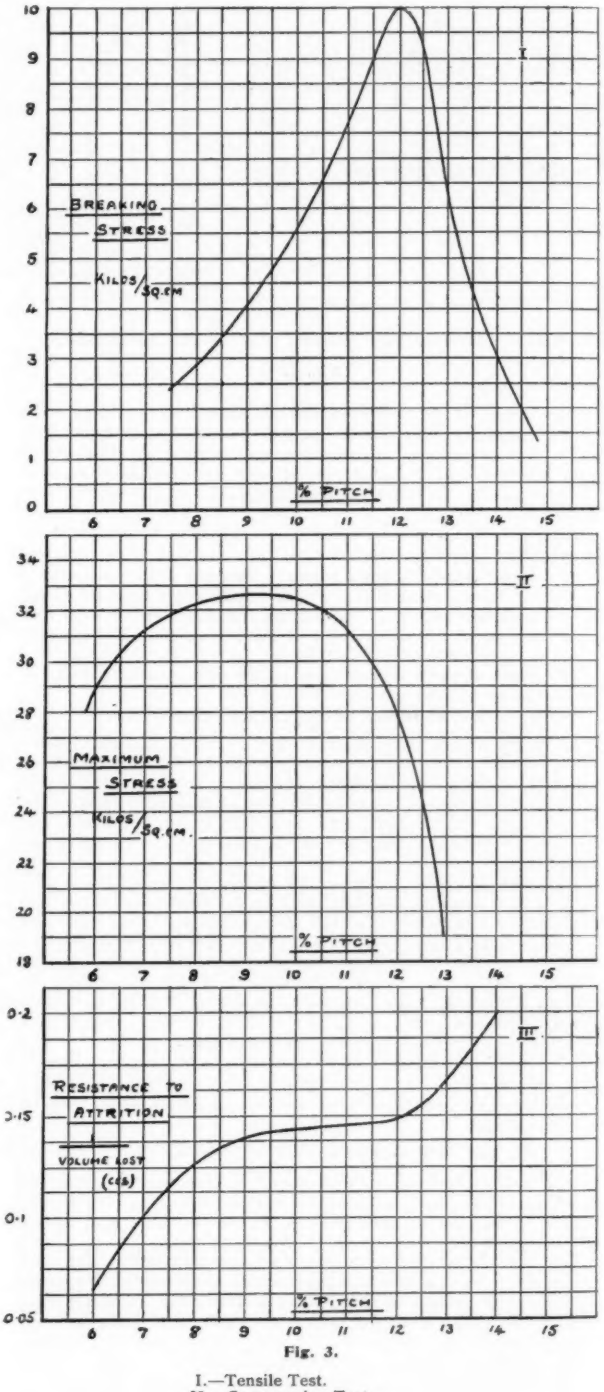


Fig. 3.

I.—Tensile Test.
II.—Compression Test.
III.—Sand-Blast Attrition Test.

Other tests are now undergoing similar investigation.

In this paper, the authors have endeavoured to draw attention to some of the many factors involved in this comparatively new section of road research.

They are of the opinion that it would be premature to put forward definite recommendations as to technique at the present time in view of the considerable amount of investigation work in progress.

Experiments with Service Governors*

By N. F. D. Wardle, of Bath.

To fit governors on all services regardless of conditions prevailing would be looked upon as an unnecessary expense. I consider, however, that it is not only desirable but necessary to have a governor on every service if maximum efficiency is to be obtained from consumers' apparatus.

One must find a governor which will not only maintain the outlet pressure but which will give a pressure line rising in proportion to the rate of flow. This effect is called compensation. I know of two makers who produce an article for which they claim this function.

I have tested these governors, which I will call A and B, and give the results of the test below.

A. This governor was designed to pass gas at the rate of 90 c.ft. per hour, having ¾ in. inlet and outlet. Referring to fig. 1, I have plotted the outlet pressure with varying consumption for four different inlet pressures. The line at the bottom is that given by a normal type of service governor having an inlet pressure of 8 in. The four lines above are given by the compensating governor.

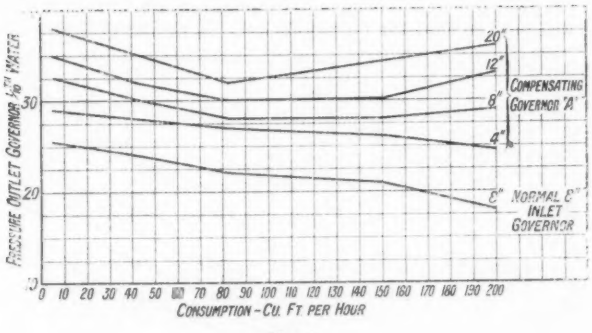


Fig. 1.

It will be seen that the line given by the constant pressure governor shows a steady fall as consumption increases. The fall amounts to a matter of 3 tenths when the rate of consumption has reached 90 c.ft. per hour.

Effect of Inlet Pressure.

The first thing to be learnt from the lines given by the compensation governor is that the outlet pressure rises in proportion to the inlet pressure. Obviously a most unsatisfactory state of affairs.

The bottom line is plotted with 4-in. pressure on the inlet. The next with 8-in., the next with 12-in., and the top line with 20-in. inlet. Had the governor done its duty the lines would at least have started together on the same level. It follows that the governor outlet pressure is influenced by the inlet pressure.

Effect of Consumption.

Taking the line immediately above the bottom line—that is, the 4-in. inlet pressure—you see a steady fall as consumption rises. The line given with 8-in. pressure on the inlet is slightly better but falls rather steeply at first. After 90 c.ft. per hour is reached, the line flattens out, and by the time 200 c.ft. per hour is reached it has actually risen half-a-tenth.

The 12-in. line is very similar to the previous one, but a very distinct rise takes place with high consumption. Finally the 20-in. inlet gives a line which follows the other up to 90 c.ft. per hour, when it begins to rise comparatively steeply.

With regard to the compensation effect, you will see that no compensation takes place in any case until a rate of 90 c.ft. per hour is reached, and then only with an inlet pressure of 12 in. or more. As 90 c.ft. per hour is the rated capacity of the governor it seems that the compensating effect obtained after this figure is reached is of no value whatever.

With regard to the second governor, which I am calling B, results were somewhat different. This governor was designed for 1¼-in. connections.

Consider the bottom line in the next diagram, which shows the outlet pressure line of this governor with varying consumption. Only one line is given in this case because it was found that the governor was not affected by inlet pressure variations. The line was made with a steady inlet pressure of 6 in. The compensating effect is clearly seen here, but it must be remembered that the scale is large and the actual maximum rise of the outlet pressure was only 3½ tenths at a rate of 800 c.ft. per hour. This is certainly a step in the right direction, but the compensating effect is too slight to be of any material use.

In view of the foregoing facts it appears that makers have begun to realize the need for such a governor, but they do not seem to have hit upon the right method of obtaining it.

It appears that the makers of the first governor have sacrificed everything to the compensating effect. Even then they do not obtain this until high consumptions are reached, and unless the inlet pressure is in the region of 20 in. of water.

In the second case it is seen that the governor fulfils all the functions of a service governor but does not show enough compensation to make any material difference.

Governor Loading.

After carrying out these tests I began to think of means by which this compensating effect could be obtained, but I regret that I am not at liberty to disclose the nature of the experiments at the moment. I have, however, some pressure curves which will give you an idea of what has been achieved.

It is clear, I think, that a compensating governor, to be of any real use, must be adaptable to the conditions prevailing in the system for which it is supplied. Factors such as the maximum degree of compensation required and the rate of flow at which it shall take place must obviously depend upon the state of the service, the degree to which the house piping is overloaded, and to some extent on the habits of the consumer.

I think it will be clear from the diagrams that I have produced a governor which will fulfil the function of a compensating governor in almost any circumstance. These lines represent as before the outlet pressure thrown by the governor at various rates of flow. The vertical scale is in tenths of an inch water gauge, the horizontal scale rate of flow in cubic feet per hour (fig. 2).

Each line represents a different setting of the governor to suit a certain set of conditions. All lines were obtained with a steady inlet pressure of 6 in.

Take the top line on the left. In this case the governor is set to give its maximum compensation at about 200 c.ft. per hour. The actual pressure increase is 3½ tenths at 200 c.ft. This is the same rise as was given by the compensating governor B at a rate of 800 c.ft. per hour.

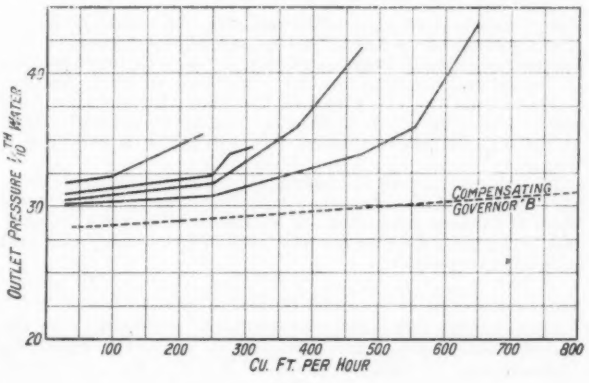


Fig. 2.

The next line below is given by the governor when set for a maximum of 300 c.ft. per hour. In this case the degree of compensation is also 3½ tenths, but this is not reached until higher up the consumption scale.

The third line down is given by a setting for higher consumption still. You will see that the 3½ tenths compensation is given at about the same rate of flow as in the last case, but the line continues to rise until a rate of 470 c.ft. per hour is reached. At this point the governor outlet pressure has been increased by 11 tenths. This I consider

* From a paper before the Western Junior Gas Association, Bristol, Oct. 21.

to be rather more than is necessary, but no doubt in certain conditions it might be useful.

Finally, the fourth line down is given with a setting for 650 c.ft. per hour. When this rate of flow is reached the outlet pressure has risen 14 tenths.

I have made tests for the effect of varying inlet pressure and find that no change in the line is visible with pressures varying from 6 in. up to 20 in. That is to say, the governor is working in the normal way besides giving the compensating effect.

In putting this type of governor into use I would suggest the following procedure.

The undertaking's inspector would make a test upon the system where the governor was to be fixed. He would be required to find out the maximum rate of consumption in the house and at the same time, by taking pressures at various points in the house, discover the conditions prevailing in the system at times of maximum load. He would then select a governor set to deal with the maximum load and giving what he considered a suitable degree of compensation. No doubt a certain amount of experience would be necessary in deciding upon the degree of compensation, but I do not anticipate any difficulty arising from the point.

If it were found that too large a stock of governors had to be carried to meet all cases it would be an easy matter to carry only standard governors, together with a supply of the necessary fittings to connect them to any degree of compensation.

The process of adjusting a standard governor for any set of conditions would not take ten minutes and does not require any special skill.

Design of Town Gas-Fired Furnaces*

By F. L. Atkin, A.M.I.Mech.E., City of Birmingham Gas Department.

It is proposed to deal with gas fired furnaces for temperatures of 600° C. to 1200° C. with a definite object in view. A moment's reflection will show that two factors are common to most of such furnaces:

1. They contain a refractory or similar material.
2. They are used mostly for the heating of metals.

With regard to the first point, the fact that such furnaces contain refractories with or without insulation materials makes it imperative to make a close study of such materials *as applied* to the furnaces in question. The general subject of "Refractories" is immense and much information is available, but the various types and qualities are so varied as to make the determination of constants almost impossible. This will be dealt with later.

Concerning the second fact: the heating of metals covers the annealing (ferrous and non-ferrous), normalizing, carburizing, and heat-treatment of steels. It is suggested not that the gas used for these purposes constitutes the greatest proportion of the total industrial gas load, but that, while remaining probably the largest itemized industrial gas load, it is subject to strong competition from other fuels, to mis-application due to an imperfect appreciation of the requirements of such furnaces, and to severe criticism from the users. Rightly or wrongly, when the competition of fuels is spoken of, the heat-treatment furnace is the one that looms large in the minds of the technical public. Hence it is considered that a close study of this matter is well worth while.

Size of Furnaces.

As will be shown later, the size of a furnace has a tremendous influence on its relative efficiency. The smallest size of furnace surveyed was one having a hearth area of about 1 sq. ft. Anything smaller was considered to be such that the actual furnace efficiency (true thermal efficiency) was subservient to the primary use of the furnace—*e.g.*, hardening of small high-speed steel tools, and small muffles of the laboratory type used by jewellers and other fine art workers. At the other end of the scale, furnaces up to a size of about 20 sq. ft. of hearth area were examined, and, as subsequent figures showed, this size could be extended if necessary.

In order to arrive at comparative results, it was necessary to consider certain common features. The general class of furnace examined was of the in-flame oven, in-and-out type, with door at one end, under-fired, and with and without recuperators.

Heat Lost to the Flue.

Considerable discussion has taken place elsewhere on the specific heat of gases. For many years the values of Holborn and Henning (published in 1907) were accepted. It has been suggested that these are too low. The writer has therefore taken the latest publishd figures (1932) on the subject. They are as follows:

Mean Thermal Capacity per Cubic Foot at t° F. above 60° F.

CO_2 . . $0{\cdot}02414 + 3{\cdot}589t \times 10^{-6} - 2{\cdot}27t^2 \times 10^{-10}$. Eq. 1
H_2O . . $0{\cdot}02200 + 4{\cdot}804t \times 10^{-7} - 6{\cdot}014t^2 \times 10^{-10}$. Eq. 2
Air N_2, O_2 $0{\cdot}01836 + 4{\cdot}964t \times 10^{-7} + 3{\cdot}54t^2 \times 10^{-11}$. Eq. 3

Working from the above formula, and using a typical gas analysis for a 475 C.V. gas, the curves on fig. 1 have been plotted.

* From a paper before the Midland Junior Gas Association, Nov. 2, 1933.

Referring to these curves, it will be seen that they are practically straight lines within the limits under discussion. Straight lines have been superimposed on the curves, and it will be seen that the maximum error is not more than 1%.

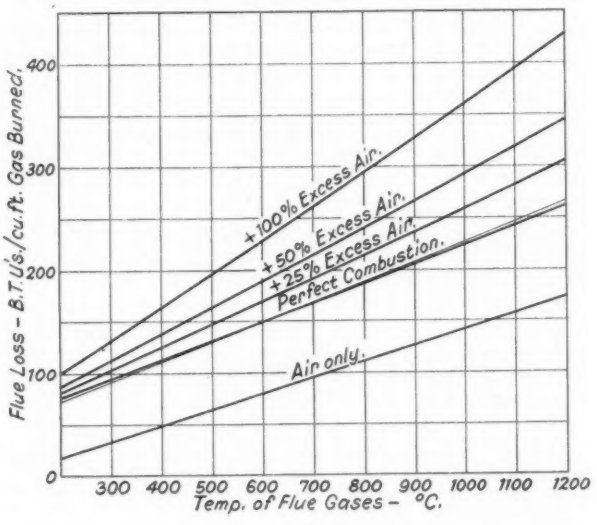


Fig. 1.—Flue Losses.

A mathematical analysis of the curve (which is a straight line) for theoretical mixture gives

Heat capacity of typical gas $= 0{\cdot}191t + 34{\cdot}2$ . . . . . Eq. 4
Where t = temperature °C. between 200° C. and 1200° C.

The curve on fig. 2 was plotted showing on a temperature base the heat capacity per B.Th.U. of the heat capacity of the theoretical mixture per 1% of excess air.

It will be seen that, if the ordinates are multiplied by one hundred, the curve will give the percentage increased loss per cent. of excess air, and from this point of view is very interesting, as it shows that with, say, 100% excess air, over 61% increased loss takes place at 1000° C. compared with about 40% increased loss at 300° C. under the same conditions, or, to put it another rather practical way, the proportionate increase in loss due to excess air is greater at the higher temperatures.

By substituting a straight line for the range 200° C. to 1100° C., the equation to the straight lines becomes

Heat capacity per B.Th.U. capacity of theoretical mixture per 1% of excess air $\left(\frac{Xa}{100}\right)$ . . . . . $= 2{\cdot}7t \times 10^{-6} + 3{\cdot}52 \times 10^{-3}$ . . Eq. 5

Combining this with Eq. 4.

Heat capacity at any temperature in t° C. between 200° C. and 1200° C. for a given excess air percentage Xa . . . . $= (0{\cdot}191t + 34{\cdot}2)\,[1 + Xa\,(2{\cdot}7t \times 10^{-6} + 3{\cdot}52 \times 10^{-3})]$ . . Eq. 6

By comparing the results of this formula with the actual heat capacity curves given on fig. 1, it was found that the maximum error introduced was not more than 2%, which,

it is suggested, is within the range of experimental errors due to temperature measurements, gas analysis, and volumetric determinations.

Heat Required to Maintain a Given Temperature.

In considering the design of a furnace, a factor of great importance is the amount of heat required to maintain a furnace at a given temperature. The heat lost from 1 sq. ft. of surface exposed to radiation and convection is given by:

$$C(t_2 - t_1)^n + 17{\cdot}3\epsilon \times 10^{-10}(T_2^4 - T_1^4) \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eq. 7}$$

where C = coefficient of convection
ϵ = ,, emissivity
n = a value suitable to the type of convection (*i.e.*, natural or forced)

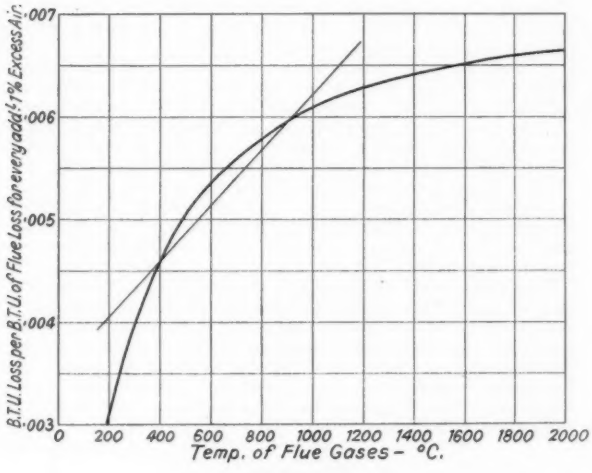


Fig. 2.—Excess Air Loss.

The evaluation of these several coefficients depends on:

(*a*) Temperature of the surface emitting.
(*b*) Temperature of the surroundings.
(*c*) Velocity of the air film.
(*d*) Roughness of the surface.
(*e*) Colour of the surface.
(*f*) Material of the surface.

A consideration of Fishenden's work led the writer to believe that suitable values of the constants would be as follows:

C . . . . . = 0·32
ϵ . . . . . = 0·9
n . . . . . = 1·25

Numerous examples from practical experience were worked out using the above coefficients, and close agreement was found in some cases, the general tendency being for the equation to give a low result. These examples were worked out from external temperatures and not from Heat Flow to the casing. The difficulty in this respect is to assess the correct value to the average temperature, because (considering the type of apparatus the writer has in mind) the temperatures are far from being uniform.

The calculations were more nearly correct at the low temperatures of casings—*i.e.*, with the better insulated furnaces, but in the writer's opinion this is due to an external condition affecting the coefficient of convection, which, in the value given, is for still air. The condition mentioned is due to the fact that, where imperfectly insulated furnaces are installed, owing to the high temperature attained by the casing an efficient system of air change in the furnace room is called for (usually open doors, roofs, &c.) which causes currents of cold air to blow over the casings and so alter the convection coefficient from that of natural convection.

The heat required for the radiation losses is supplied by the heat transmitted through the furnace walls.

Total Heat Transfer.

It has been suggested by several authorities that the analogy may be drawn between "Resistances in Parallel" by using the following equation:

$$\left.\begin{matrix}\text{Heat transmitted}\\ \text{per square foot}\\ \text{per hour}\end{matrix}\right\} = \frac{(t_2 - t_1)}{\frac{1}{C_1} + \frac{d_2}{k_2} + \frac{d_2}{k_3}\ \&c. + \frac{1}{C_0}} \quad . \quad . \quad . \quad \text{Eq. 8}$$

where t_2 and t_1 = Temperature of the inside of the furnace and the outside air respectively.
C_1 and C_0 = Surface transfer coefficients of the inside and outside of the furnace.
d_2, d_3, &c. = The thickness of the various materials (firebrick, insulation material, iron plates, &c.), in inches.
k_2, k_3, &c. = The thermal conductivity of the respective materials of construction.

In working out problems on the furnaces outlined in this paper, it would be impracticable to consider the walls as projected areas normal to the inside surface of the furnace, owing to the very considerable corner effect; to avoid this difficulty, the mean areas of the respective materials of construction were taken and interposed in Eq. 8 as follows:

$$\text{Total heat loss} = \frac{(t_2 - t_1)}{\frac{1}{A_1C_1} + \frac{d}{A_2k_2} + \frac{d}{A_3k_3}\ \&c. + \frac{1}{A_0C_0}} \quad . \quad . \quad \text{Eq. 9}$$

where A_1, A_2, A_3, &c., and A_0 = areas of the inside, the mean areas of the materials, and the outside area of the furnace respectively.

By making several comparative calculations it was found that the effect of the furnace casing as a resistance to heat transmission was negligible.

Using the foregoing formula and the constants of the various materials (as given out by the manufacturers of firebrick and insulating materials) a large number of examples were worked out and compared with actual results the writer had obtained from time to time. The results were not very favourable, giving in almost every case a much smaller figure than that actually obtained.

It was also noticed that in several text-books, mostly of American origin, constants were used which were much higher than those given by the manufacturers of material.

It is interesting at this stage to quote Searle ("Refractory Materials," 1924), who says: "It should be remembered that the results of the thermal conductivity tests on single bricks in a test-furnace do not strictly give results comparable to those obtained when the same bricks are used in a furnace. . . ." Unfortunately, there is very little information on the actual thermal conductivity of firebricks, when *in situ*, so that it is almost impossible to take into consideration the difference between the thermal conductivity of a firebrick as found experimentally and that of the brick when in actual use.

From figures at the writer's disposal a large number of calculations were made with various conductivities and surface transfer coefficients. It was found that if the thermal conductivity was taken as between 7 and 9 B.Th.U. transmitted per square foot per hour per 1° F. difference, and 1 in. thick, and the inside surface transfer coefficient between 10 and 15 and the outside surface transfer coefficient between 1·3 and 5, the choice of ratios between these limits depending on the inside and outside temperatures (as all these values increase with increasing temperatures), results accurate to within 10% of the test figures were obtained.

From the data on coefficients obtained from the above a further large series of calculations was carried out.

To obtain the necessary curves, which was the object of the writer, several features were "standardized" as follows:

1. *Temperature.*—To obtain results over the range covered, three temperatures were used—viz., 700° C., 900° C., 1100° C.
2. *Thickness of Firebrick Walls.*—This has been taken as 4½ in., being the thickness mostly used.
3. *Thickness of Insulation.*—Two thicknesses have been taken—viz., 4½ in. and 9 in., which, together with zero thickness (*i.e.*, 4½ in. firebrick only) completes the series.
4. *Size of Furnace.*—The following sizes have been taken:

	Long	Wide.	High.
(*a*)	4 ft. 6 in.	× 3 ft. 0 in.	× 1 ft. 6 in.
(*b*)	3 ft. 0 in.	× 2 ft. 0 in.	× 1 ft. 0 in.
(*c*)	2 ft. 0 in.	× 1 ft. 6 in.	× 1 ft 0 in.
(*d*)	1 ft. 6 in.	× 1 ft. 0 in.	× 9 in.

It will be seen that they fall in the group of the ratio 3:2:1 (see previous notes) as far as practical, while still retaining commercial dimensions; also they come within the practical limits of size which the writer intends to discuss.

5. *Doors.*—The type taken has varied with the class of furnace as follows:

For 4½ in. firebrick uninsulated, 4½ in. firebrick door
,, 4½ ,, ,, and 4½ in. insulation, 6 in. insulated door
,, 4½ ,, ,, ,, 9 ,, ,, 9 ,, ,, ,,

6. *Type of Furnace.*—Non-recuperative.

To sum up, it will be seen that there are four sizes of furnaces, three types to each size, and three temperatures for each size and type, making thirty-six complete calculations to be made, together with the necessary door cal-

culations—some seventy-two calculations of Equations of the form given in Eq. 9.

Correlating Results.

It became necessary to express these results on some common basis. It was decided to express them on a basis

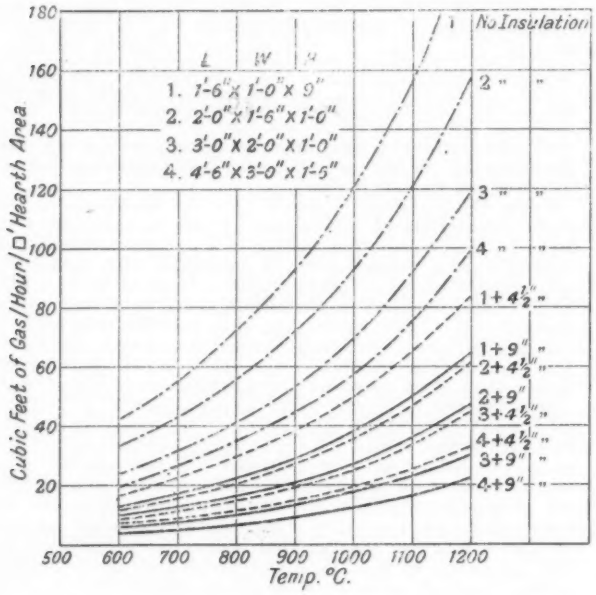


Fig. 3.

of 1 sq. ft. of hearth area. The alternative would have been per cubic foot of volume, but the writer is of the opinion that in practice (with certain exceptions) the deciding factor is the hearth area.

It will be seen from fig. 3 that the proportionate amount of gas required to maintain a certain temperature under a given set of conditions increases enormously when the smaller sizes are reached.

The reason for this is obvious when the curves on fig. 4 are inspected, which show the internal surface and external surface per square foot of hearth area. This ratio of external and internal areas to hearth area is most important from an economical viewpoint. It is, in fact, in another form, the old thermo-dynamic problem of surface to volume ratio as applied to internal combustion engine head design, but very much more complicated by the fact that the surfaces are comparatively thick and of low thermal conductivity, as compared with the high thermal diffusivity of a cylinder head.

On fig. 5 is shown the percentage saving which is effected by various thicknesses of insulation as compared with a furnace having 4½ in. firebrick only.

It will be seen that, for economical working, furnaces should be chosen having at least 6 sq. ft. of hearth area.

It is realized, of course, that in certain cases, a furnace of this size is not required, but it should be clearly understood that the results obtained could not be compared on a true efficiency basis with those of a larger capacity.

With regard to insulation, from fig. 5 it will be noticed that considerable economies can be obtained from small thicknesses of insulation—*e.g.*, 3 in. thickness of insulation will give a 50% saving, whereas 9 in. is required to increase this saving to 75%.

From the curve of percentage saving, it is noticed that this saving is independent of the working temperature. It appears, therefore, that a thickness of approximately 6 in. represents probably the most economical thickness. This would, however, have to be compared with the costs of the insulation, and the extra cost of accommodating it, which it is not proposed to investigate, as it would make the paper unduly long.

Recuperation.

It is frequently necessary to work out figures for furnaces equipped with various types of recuperators, and for the purposes of these calculations it is necessary to know the

This Model Coin Collector

Was *supplied* in 1901

And is *still* in use

Telephones:
MANCHESTER: 2289 COLLYHURST
NOTTINGHAM: 75202
WATFORD 2645

Telegrams:
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Quality Tells

SOLE MAKERS: SAWER & PURVES
(BRANCH OF METERS LTD.)

NELSON METER WORKS MANCHESTER 10
DERBY ROAD WATFORD
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number of B.Th.U. required to maintain 1 sq. ft. of hearth area at a given temperature.

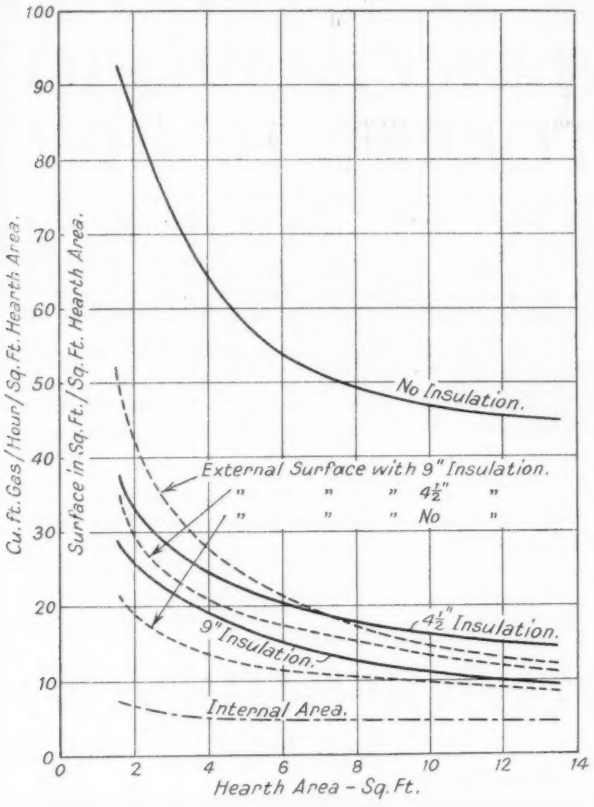

Cu. Ft. Gas / Hour / Sq. Ft. Hearth Area.
Surface in Sq. Ft. / Sq. Ft. Hearth Area.
Hearth Area - Sq. Ft.
No Insulation.
External Surface with 9" Insulation.
" " " 4½" "
" " " No "
4½" Insulation.
9" Insulation.
Internal Area.

Fig. 4.

The method is to take a value from the curves of c.ft. of gas required per sq. ft. of hearth area to maintain a certain temperature, and multiply it by the heat available at the particular temperature (fig. 1).

If the exit temperature of the gases leaving the recuperator is known, the heat wastage can be ascertained from the curves of flue losses; and hence the c.ft. of gas required per hour to satisfy the particular problem.

(*To be concluded.*)

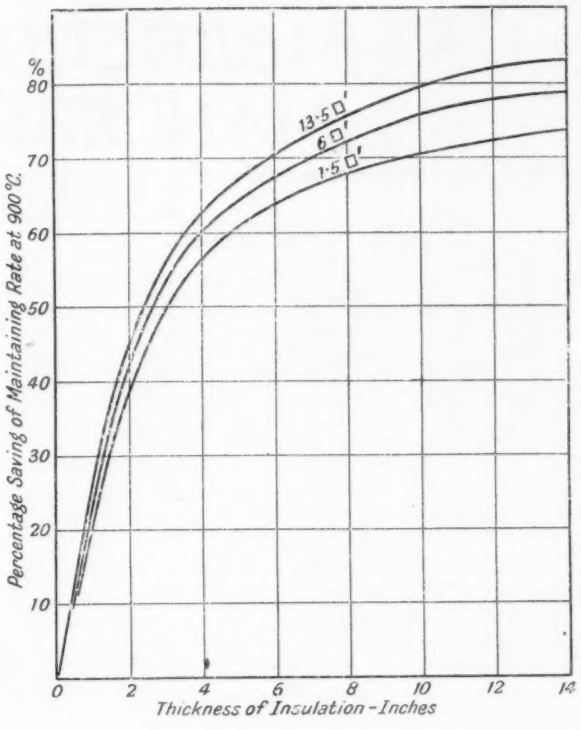


Fig. 5.

Special 3″ Diameter
STANTON-DELAVAUD SPUN IRON PIPE

s. d.
2/1½
NET PER YARD
F.O.T. WORKS

ADVANTAGES

The external diameter of the pipe and the internal diameter of the socket are to British Standard Specification. The increased bore gives an effective carrying capacity approximately 20% greater than that of an ordinary 3-inch diameter Cast Iron Pipe or Steel Tube.

The Spun metal gives a much larger factor of safety than that obtainable in the ordinary sand-cast pipe, and has a considerable degree of elasticity capable of withstanding high stresses.

All these pipes are hydraulically tested to a pressure of 200 lbs. per sq. in. before despatch.

SPECIFICATION

Actual Bore	3·28 ins.
Thickness	0·25 ins.
Length (effective)	4 yards
Weight	1 cwt.
Coating	Coated both sides, outside only, or uncoated

THE STANTON IRONWORKS COMPANY LIMITED, Near NOTTINGHAM

GAS MARKETS & MANUFACTURES

Stock Market Report.

[For Stock and Share List, see later page.]

Markets were strong and active last week, the feature being a further heavy demand for industrials, some of which, judging from the small yields obtainable thereon, have now almost reached "boom" prices. It is interesting to note that, despite the large appreciation in these issues, gilt-edged securities also continue to rise in value and are well supported. The preliminary reports of four of the leading banks indicate that the past year was by no means an unfavourable one. In three cases profits were higher, while all are distributing the 1932 rates of dividend.

In common with other high-class investment issues, the values of Gas stocks and shares are being well maintained. Several further increases took place last week. Gas Light units continue to gain ground, and advanced 3d. to 26s. 9d. Brighton 5% and Imperial Continental both rose 3, while Southampton 5% maximum, Primitiva 4% debenture, and Swansea 6½% debenture all increased 2. Business was not on a large scale, which is usually the case at this time of the year by reason of the close proximity of dividend disbursements, the announcements of which will shortly be appearing. These are awaited with interest, and there is every indication that here again the reports and accounts for the past year will not be unsatisfactory.

Current Sales of Gas Products.

The London Market for Tar Products.

LONDON, *Jan.* 8.

The prices of tar products continue unchanged, and current prices are as follows:

Pitch, about 65s. per ton f.o.b.

Creosote, 3d. to 3¼d. per gallon.

Refined tar, 4d. to 4¼d. per gallon in bulk at makers' works.

Pure toluole, 3s. to 3s. 3d.; pure benzole, 1s. 10d. to 1s. 11d.; 95/160 solvent naphtha, about 1s. 9d.; and 90/140 pyridine bases, 5s. 3d. to 5s. 6d.—all per gallon naked at makers' works.

Tar Products in the Provinces.

Jan. 8.

The average prices of gas-works products during the week were: Gas-works tar, 25s. to 30s. Pitch—East Coast, 61s. 6d. to 64s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 61s. 6d. to 64s.* Toluole, naked, North, 2s. 5d. to 2s. 7d. Coal-tar crude naphtha, in bulk, North, 6½d. to 6¾d. Solvent naphtha, naked, North, 1s. 7d. to 1s. 7½d. Heavy naphtha, North, 10½d. to 11d. Creosote, *ex* works, in bulk, North, liquid and salty, 2½d. to 2¾d.; low gravity, 2d. to 2½d.; Scotland, 2½d. to 2¾d. Heavy oils, in bulk, North, 3¾d. to 4½d. Carbolic acid, 60's, 2s. 1½d. to 2s. 2½d. Naphthalene, £10 to £11. Salts, 55s. to 75s., bags included. Anthracene, "A" quality, 2½d. to 3d. per minimum 40%, purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Jan.* 6.

Pitch remains weak, but other products are in good call with supplies on the short side.

Crude gas-works tar.—The actual value is 40s. to 42s. per ton *ex* works.

Pitch.—Export business is purely nominal at 57s. 6d. to 60s. per ton f.o.b. Glasgow. Small quantities for home consumption command 60s. per ton *ex* works in bulk.

Refined tar is quietly steady at 3¼d. to 3⅜d. per gallon f.o.r. in buyers' packages.

Creosote oil.—There is a steady demand, and prices are firm. B.E.S.A. specification is 3¾d. to 4d. per gallon; low gravity, 3¾d. to 4d. per gallon; and neutral oil, 3¾d. to 4d. per gallon—all in bulk *ex* works.

Cresylic acid.—Prompt supplies are scarce and values are higher. Pale, 97/99%, is 1s. 1d. to 1s. 2d. per gallon; dark, 97/99%, 11d. to 1s. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 5d. per gallon—all f.o.r in buyers' packages.

Crude naphtha.—Available supplies command 4½d. to 5d. per gallon, according to quality and quantity.

Solvent naphtha.—90/160 grade is 1s. 6d. to 1s. 7d. per gallon, and 90/190 quality is 1s. per gallon.

Motor benzole is still nominal at 1s. 7d. per gallon *ex* works.

Pyridines.—90/160 grade is 4s. to 4s. 3d. per gallon, and 90/140 grade is 4s. 6d. to 5s. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole	0 10	to	0 10½	per gallon at works
Motor ,,	1 5	,,	1 5½	,, ,, ,,
90% ,,	1 5½	,,	1 6	,, ,, ,,
Pure ,,	1 8¼	,,	1 9	,, ,, ,,

Trade Notes.

Aluminium Sheet Metal Work.

A booklet has been published by the British Aluminium Company, Ltd., of Adelaide House, King William Street, E.C. 4, on the subject of aluminium sheet metal work. This publication contains much informative technical data, together with some photographic examples of sheet metal work embodying aluminium and its alloys.

Diaries, Calendars, &c.

Receipt is acknowledged of further seasonable gifts in the form of diaries, calendars, &c., from the undermentioned friends, whose good wishes are heartily reciprocated:

BRITISH JEFFREY-DIAMOND, LTD., Wakefield.

BROTHERTON & CO., LTD., City Chambers, Leeds.

CHEMICAL TRADE JOURNAL AND CHEMICAL ENGINEER, 265, Strand, W.C. 2.

R. & J. DEMPSTER, LTD., Manchester.

GIBBONS BROS., LTD., Dudley.

PECKETT & SONS, LTD., Bristol.

F. J. WILLMER & CO., 19, Water Lane, E.C. 4.

New Capital Issues.

East Hull Gas Company.—As will be seen from our advertisement columns, Messrs. A. & W. Richards are offering for sale by tender £60,000 of 4½% preference stock in this Company at a minimum price of issue of £103 per £100 of stock. The yield at this price is £4 7s. 5d.%. Tenders must be received not later than 11 a.m. on Thursday, Jan. 25.

Gas Companies' Results.

Churnet Valley.

The revenue account of the Churnet Valley Gas Company, Ltd., for the year ended Sept. 30, 1933, shows a profit of £1006. To this has to be added the unappropriated balance from the previous year of £826, making a total of £1832. Against this has to be charged debenture interest and bank interest, making together £343, leaving for disposal the sum of £1489. The Directors recommend that this shall be applied in paying a dividend for the year ended Sept. 30, 1933, at the rate of 5% per annum (less tax), and by carrying forward to the current year the balance of £739.

A UNIQUE & AMAZING METHOD OF OVEN CONSTRUCTION WHICH NO OTHER COOKER POSSESSES !

TILED OR WILLOW PATTERN EXTERIOR ENAMELS

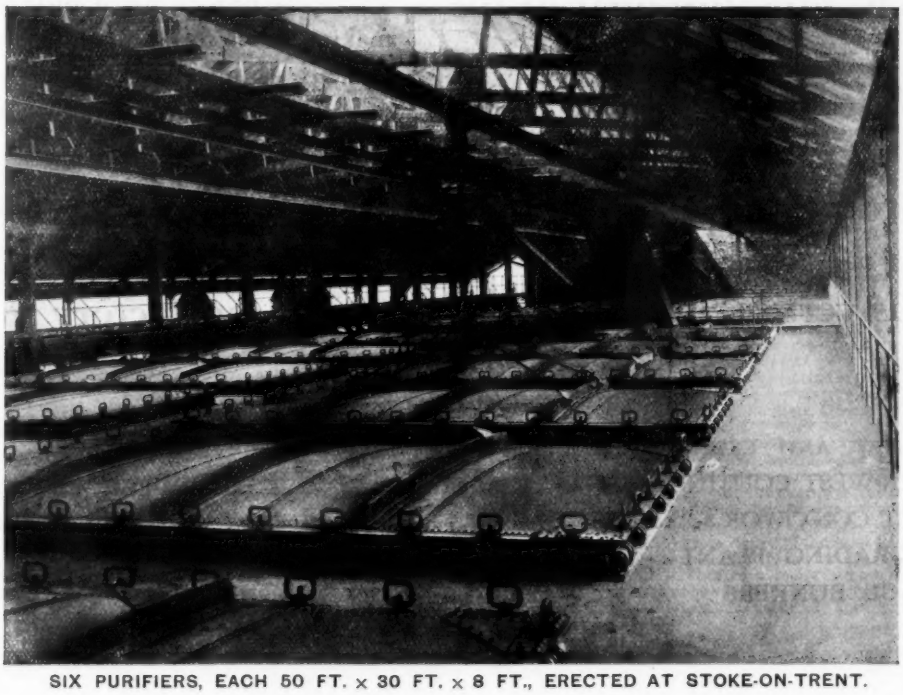
THE GOVERNOR-GENERAL GAS COOKER is the most striking advance in the development of the SINGLE BURNER OVEN.

THE PATENT BOTTOM FLUE by its ingenious method of construction compels the heat to circulate throughout the entire oven, giving a BETTER Heat Distribution before it leaves at the Bottom by means of the PATENTED DOOR FLUE. The Heat then takes its natural course up the flue in the door, along the passage over the dome of the cooker, and finally passing out of the flue outlet in the CORRECT POSITION at the top of the oven.

THE AUTOMATIC OVEN CONTROL ASSURES ECONOMICAL AND EFFICIENT COOKING SERVICE

GOVERNOR-GENERAL GAS COOKER

General Gas Appliances Ltd.
Audenshaw, Manchester



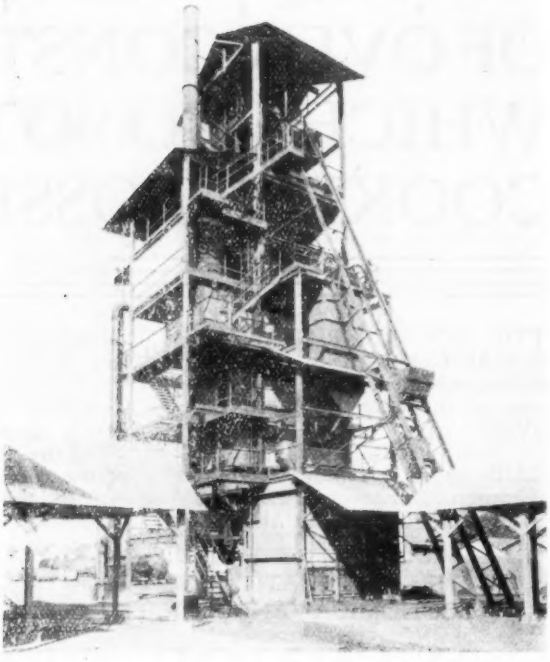
SIX PURIFIERS, EACH 50 FT. × 30 FT. × 8 FT., ERECTED AT STOKE-ON-TRENT.

COMPLETE PURIFIER INSTALLATIONS.

C. & W. WALKER, LTD. DONNINGTON, NR. WELLINGTON—SHROPS.

LONDON OFFICE: 70, VICTORIA STREET, WESTMINSTER, S.W. 1.

Another "Repeat Order" for Glover-West Verticals



VANNES This installation of continuous verticals on the Glover-West system was built in 1929 by the Cie. Gle. de Construction de Fours at Vannes, in Brittany. The same company has just received a "repeat order" for 4 further retorts, making 10 retorts in all, with a daily capacity estimated at 15,000 cu. metres, or more than half a million cubic feet.

No fewer than 147 plants in the total of 350 now installed to the Glover-West design, have been "repeat orders" for extensions to installations of Glover-West continuous vertical retorts already giving satisfactory service.

PROMPT AND EXPERT ATTENTION IS GIVEN TO ALL ENQUIRIES FOR GLOVER-WEST CONTINUOUS VERTICAL RETORTS . . . . THE "WEST" LIPPED BUCKET CONVEYOR . . . . THE "CALVERT" COKE CUTTER . . . . SCREENING AND GRADING PLANT . . . . WAGON TIPPLERS . . . . SKIP-HOISTS . . . . STORAGE BUNKERS . . . . WASTE HEAT RECOVERY EQUIPMENT, &c.

WEST'S GAS IMPROVEMENT CO., LTD.

MILES PLATTING, MANCHESTER, 10. *'Phone:* COLLYHURST, 2961 - *'Grams:* STOKER, MANCHESTER

STOCK AND SHARE LIST.

Official Quotations on the London and Provincial Stock Exchanges.

Issue. £	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations. Jan. 6. (Provincial Exchanges Jan. 5.)	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
1,551,868	Stk.	Oct. 9	7	7	Alliance & Dublin Ord. ...	122—132	...	130
374,000	"	July 10	4	4	Do. 4 p.c. Deb. ...	90—100	...	...
557,655	"	Aug. 28	7	7	Barnet Ord. 7 p.c.	167—172	...	169
300,000	1	Oct. 23	1/9½	1/4½	Bombay, Ltd.	26/—28/-	...	27/—28/-
178,280	Stk.	Aug. 14	9½	9½	Bournemouth sliding scale	195—205	...	...
550,050	"	"	7	7	Do. 7 p.c. max. ...	163—168	...	...
439,160	"	"	6	6	Do. 6 p.c. Pref ...	136—140	...	...
50,000	"	Dec. 18	3	3	Do. 3 p.c. Deb. ...	75—80*	...	...
162,025	"	"	4	4	Do. 4 p.c. Deb. ...	100—105*	...	...
210,000	"	"	5	5	Do. 5 p.c. Deb. ...	118—123*	...	...
357,900	"	Aug. 28	7½	7½	Brighton, &c., 6 p.c. Con ...	163—168	+½	...
540,000	"	"	6½	6½	Do. 5 p.c. Con. ...	150—155	+3	152½
195,500	"	"	6	6	Do. 6 p.c. B. Pref.	136—141	...	...
1,487,500	"	July 24	5	5	Bristol 5 p.c. max	114—115*a*	...	...
120,420	"	Dec. 18	4	4	Do 1st 4 p.c. Deb. ...	98—99*a*	...	...
217,870	"	"	4	4	Do. 2nd 4 p.c. Deb. ...	98—99*a*	...	...
328,790	"	"	5	5	Do. 5 p.c. Deb.	119—121*a*	...	...
855,000	"	Sept. 25	8	7	British Ord.	155—160	...	157
100,000	"	Dec. 18	7	7	Do. 7 p.c. Pref.	145—150*	...	...
350,000	"	"	5½	5½	Do. 5½ p.c. Pref.	106—111*	...	...
120,000	"	"	4	4	Do. 4 p.c. Red. Deb. ...	95—100*	...	...
450,000	"	"	5	5	Do. 5 p.c. Red. Deb. ...	107—112*	...	...
160,000	"	June 26	5	5	Cambridge 5 p.c. Deb. ...	115—120	...	...
100,000	10	May 22	6	4	Cape Town, Ltd.	6⅞—7⅞	...	...
100,000	10	Nov. 6	4½	4½	Do. 4½ p.c. Pref. ...	6⅞—7⅞	...	...
150,000	Stk.	Dec. 18	4½	4½	Do. 4½ p.c. Deb. ...	98—98*	...	...
626,860	"	July 24	6	6	Cardiff Con. Ord.	123—128	...	126
237,860	"	June 26	5	5	Do. 5 p.c. Red. Deb.	105—110	...	...
157,150	"	Aug. 14	6½	5	Chester 5 p.c. Ord.	115—125*b*	...	...
98,936	1	Oct. 9	2/-	2/-	Colombo, Ltd. Ord.	1⅞—1½	...	...
24,500	1	"	1/4½	1/4½	Do. 7 p.c. Pref. ...	19/-—21/-	...	...
609,204	1	Oct. 9	/11'48	/11'48	Colonial Gas Assn. Ltd. Ord.	1⅞—1⅞	...	...
296,053	1	"	1/3'30	1/3'30	Do. 8 p.c. Pref.	26/3—27/3	...	...
1,775,005	Stk.	July 24	6½	5	Commercial Ord.	122—127	...	124
475,000	"	Dec. 18	3	3	Do. 3 p.c. Deb. ...	74—79*	...	74
286,344	"	Mar. 6	—	5	Do. 5 p.c. Deb. ...	121—126	...	...
807,560	"	Aug. 14	7	7	Croydon sliding scale ...	150—155	...	155
469,590	"	"	5	5	Do. max. div.	105—110	...	108⅝—109½
500,000	"	July 10	5	5	Do. 5 p.c. Deb.... ...	120—125	...	...
542,270	"	Mar. 6	7	10	Derby Con.	170—180*e*	...	...
55,000	"	July 10	4	4	Do. 4 p.c. Deb.	98—100*e*	...	...
209,000	"	Aug. 28	5	5	East Hull Ord. 5 p.c.	108—113	...	...
179,500	"	Aug. 28	6	6	East Surrey Ord. 5 p.c. ...	128—133	...	...
155,019	"	Dec. 18	5	5	Do. 5 p.c. Deb. ...	115—120*	...	...
1,002,180	"	Sept. 25	†7	†5	European, Ltd.	129—134	...	131
19,342,763	"	Aug. 14	5⅝	5⅝	Gas Light & Coke 4 p.c. Ord.	26/3 - 27/3*f*	+·/3	26/7½—27/1½
2,600,000	"	"	3½	3½	Do. 3½ p.c. max. ..	86—89	...	88⅝—88⅝
4,477,105	"	"	4	4	Do. 4 p.c. Con. Pref. ...	102—105	...	103—105
6,102,497	"	Dec. 18	3	3	Do. 3 p.c. Con. Deb. ...	81—84*	...	82½—84
3,642,770	"	"	5	5	Do. 5 p.c. Red. Deb. ...	113—116*	...	115½—116
3,500,000	"	"	4½	4½	Do. 4½ p.c. Red. Deb. ...	111—115*	...	114½
270,466	"	Aug. 28	6	6	Harrogate New Cons. ...	120—125	...	...
82,500	"	Aug. 28	7	7	Hastings & St. L. 5 p.c. Conv.	149—154	...	153½
258,740	"	"	5½	5½	Do. 3½ p.c. Conv.	117—122	...	...
140,000	1	Oct. 9	†10	1/7½	Hongkong & China, Ltd. ...	29/— 32/	...	29/6
213,200	Stk.	Aug. 14	6	6	Hornsey Con. 3½ p.c. ...	120—125	...	...
5,600,000	"	Nov. 6	†4	†0	Imperial Continental Cap.	213—218	+3	212½—217
223,130	"	Aug. 14	3½	3½	Do. 3½ p.c. Red. Deb.	90—95	...	...
235,242	"	Aug. 14	8½	8½	Lea Bridge 5 p.c. Ord. ...	170—175	...	...
2,145,907	"	Aug. 14	6	6	Liverpool 5 p.c. Ord. ...	130—131*b*	...	...
245,500	"	Dec. 18	5	5	Do 5 p.c. Red. Pref. ...	101—111*b*	...	...
306,083	"	July 17	4	4	Do. 4 p.c. Deb. ...	99¼—101¼*b*	...	...
165,786	"	Aug. 28	10	8	Maidstone 5 p.c. Cap. ...	180—190	...	...
56,176	"	July 10	3	3	Do. 3 p.c. Deb. ...	69—74	...	...
75,000	5	Dec. 4	†10	†10	Malta & Mediterranean ...	9—11	...	...
392,000	—	Oct. 2	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	98—103	...	...
231,978	Stk.	Aug. 28	5	5	M. S. Utility "C." Cons. ...	111—116	...	...
818,657	"	"	4	4	Do. 4 p.c. Cons. Pref.	92—97	...	96—97
112,126	"	June 26	4	4	Do. 4 p.c. Deb. ...	100—105	...	...
148,955	"	"	5	5	Do. 5 p.c. Deb. ...	118—123	...	...
675,000	"	21 May '31	†6	†6	Montevideo, Ltd.	50—60	...	...
2,061,315	"	Aug. 14	8⅔	6	Newcastle & Gateshead Con.	25/9—26/3*d*	...	...
682,856	"	"	4	4	Do. 4 p.c. Pref. ...	101—103*d*	...	...
776,706	"	July 10	3½	3½	Do. 3½ p.c. Deb. ...	92—93*d*	...	...
277,285	"	Nov 6	5	5	Do. 5 p.c. Deb. '43 ...	105—107*d*	...	...
274,000	"	Aug. 14	5	5	Newport (Mon.) 5 p.c. max.	101—104*a*	...	...
204,940	"	Aug. 28	7½	7½	North Middlesex 6 p.c. Con.	153—158	...	...
396,160	"	Aug. 14	5	5	Northampton 5 p.c. max. ...	101—106	...	...
300,000	"	Dec. 4	7	†9	Oriental, Ltd.	147—152	...	150—151
316,617	"	Dec. 18	8	8	Plym'th & Stonehouse 5 p.c.	164—169*	...	...
504,416	"	Aug. 28	8	8	Portsm'th Con Stk. 4 p.c. Std	162—167	...	166
241,446	"	"	5	5	Do. 5 p.c. max. ...	102—107	...	105
114,000	"	Aug. 14	5	5	Preston 5 p.c. Pref.	105—110	...	...
686,312	"	July 24	4	4	Primitiva 4 p.c. Rd. Db. 1911	88—93	...	90½
389,813	"	Dec. 18	4	4	Do. 4 p.c. Cons. Deb.	98—98*	+2	...
150,000	10	Sept. 25	6	6	San Paulo 6 p.c. Pref. ...	6½—7½	...	...
1,736,968	Stk.	Sept. 11	6	6	Sheffield Cons.	134—136*e*	...	...
95,000	"	July 10	4	4	Do. 4 p.c. Deb.	90—94*e*	...	...
133,201	"	Sept. 11	8	8½	Shrewsbury 5 p.c. Ord. ...	137—142	...	...
90,000	10	June 12	†5	†4	South African	3—5	...	...
6,709,895	Stk.	Aug. 14	7	5	South Met. Ord.	134—137	...	134½—136½
1,135,812	"	"	6	6	Do. 6 p.c. Irred. Pf.	137—142	...	140½
850,000	"	"	20/-*g*	4	Do. 4 p.c. Irred. Pf.	102—105	...	104
1,895,445	"	July 10	3	3	Do. 3 p.c. Deb. ...	80—83	...	...
1 000,000	"	July 24	5	5	Do. 5 p.c. Red. Deb.	112—116	...	114½
209,820	"	Aug. 14	8½	8½	South Shields Con.	170—171*d*	...	...
1,543,795	"	Aug. 14	6	6	South Suburban Ord. 5 p.c.	131—136	...	131—133
300,000	"	"	5	5	Do. 5 p.c. Pref.	114—119	...	...
300,000	"	"	—	4	Do. 4 p.c. Pref.	100—103	...	103
868,837	"	Dec. 18	5	5	Do. 5 p.c. Deb.	118—123*	...	...
100,000	"	"	4	4	Do. 4 p.c. Deb.	100—103*	...	...
647,740	"	Aug. 28	5	5	Southampt'n Ord. 5 p.c. max.	110—115	+2	...
121,275	"	Dec. 18	4	4	Do. 4 p.c. Deb.	97—102*	...	...
350,000	"	Aug. 28	5½	5½	Swansea 5½ p.c. Red. Pref.	107—111	...	...
200,000	"	Dec. 18	6½	6½	Do. 6½ p.c. Red. Deb.	103—108*	+2	...
1,076,490	"	Aug. 14	6⅔	6⅔	Tottenham and District Ord.	149—154	...	...
300,000	"	"	5½	5½	Do. 5½ p.c. Pref. ...	125—130	...	...
62,235	"	"	5	5	Do. 5 p.c. Pref. ...	112—117	...	...
199,005	"	Dec. 18	4	4	Do. 4 p.c. Deb. ...	97—102*	...	...
85,701	"	Oct. 9	6	6	Tuscan, Ltd. 6 p.c. Red. Db.	90—100	...	...
347,769	"	Aug. 28	7	7	Uxbridge, &c., 5 p.c. ...	146—151	...	...
88,330	"	"	5	5	Do. 5 p.c. Pref. ...	112—117	...	...
1,322,220	"	July 10	7	7	Wandsworth Consolidated	154—159	...	157½
1,096,373	"	"	5	5	Do. 5 p.c. Pref.	118—123	...	120½
1,317,964	"	Dec. 18	5	5	Do. 5 p.c. Deb.	118—128*	...	...
158,400	"	Aug. 28	6*h*	5	Winchester W. & G. 5 p.c. Cons.	115—120	...	...

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of stock *g.*—For quarter. *h.*—Paid £3, including 10s. on account of back dividends. *i.*—The interest due 1/7/33 was paid on that date. * Ex. div. † Paid free of income-tax. ‡ For year. Hongkong & China, Ltd.—paid on £10 shares.

STOCK FOR SALE BY TENDER.

By Order of the Directors.
EAST HULL GAS COMPANY.

Messrs. A. & W. RICHARDS
are Instructed to OFFER FOR SALE BY TENDER

£60,000
4½ PER CENT. PREFERENCE STOCK.
Minimum Price of Issue, £103 per £100.
Yielding at that Price, £4 7s. 5d. per cent.

Prospectus and Form of Tender (which latter must be sent in by 11 o'clock on Thursday, 25th January) may be obtained of A. & W. RICHARDS, 37, WALBROOK, E.C. 4.

CONTRACTS OPEN.

(*See also* p. 112.)

TAR AND BITUMEN FOR USE ON ROADS.

DEPARTMENT OF LOCAL GOVERNMENT AND PUBLIC HEALTH.

LOCAL AUTHORITIES (COMBINED PURCHASING) ACT, 1925.

THE Minister for Local Government and Public Health hereby gives public notice that he will receive Applications on or before the 30th day of January, 1934, from persons desirous of being appointed under the above-mentioned Act to be OFFICIAL CONTRACTORS during the period 1st day of April, 1934, up to the 31st March, 1935, for the supply to Local Authorities in Saorstát Eireann of the commodities set forth in the Schedule hereunder.

Applications for appointment as Official Contractor must be made on the prescribed Form of Application, copies of which can be obtained from the Office of the Department of Local Government and Public Health (TRADE DEPARTMENT), Room 44, Custom House, Dublin, and should be forwarded to this address *enclosed and sealed in the Official Envelope* which is issued for the purpose with the prescribed Form.

Particulars and specifications of each of the commodities set forth in the Schedule hereunder may also be obtained from the above address. The commodities are to be supplied in accordance with conditions set forth in the Local Authorities (Combined Purchasing) Regulations, 1926 to 1933, and in particular in accordance with the Local Authorities (Combined Purchasing) (Supply in Bulk) Regulations, 1933.

Where an applicant proposes to supply a proprietary preparation as a substitute for, or form of, the commodity in respect of which he is desirous of appointment, he must state so in his application. He must also give particulars of the composition of such preparation. Expert opinion will be taken as to the relative value of any such preparation.

The Minister will require every person appointed, as a condition of his appointment, to enter into an undertaking (included in the Application Form) to accept as correct the results of any analysis or test by the State Chemist of the commodity supplied.

Before making an appointment, the Minister will take into consideration not only the price for which the commodity is offered by each applicant, but also the quality of the goods manufactured or supplied by him, the period from the date of each order within which the applicant undertakes to make delivery, the stocks proposed to be held in this country, the records of the applicant, and any other such relevant matter. The Minister does not undertake to appoint the applicant whose price is the lowest or any applicant.

SCHEDULE.

1. Bitumen for Surface Dressing.
2. Bitumen for Asphalt Macadam.
3. Tar No. 1.
4. Tar No. 2.
5. Tar No. 3.
6. Tar Bitumen Mixture.
7. Emulsion of Bitumen and Water.
8. Cut-Back Bitumen (Mixing).
9. Cut-Back Bitumen (Spraying).

By Order of the Minister for Local Government and Public Health.

E. P. MCCARRON,
Secretary.

8th January, 1934.

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